Curriculum & Syllabus – R21

B.Tech
in
Mechanical Engineering

Effective for 2021 Admission Batch Onwards

L – Lecture; T- Tutorial; P- Practical
[1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

First Year First Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	A. THEORY			L	T	P	Total	
1	Basic Science course	CH101	Chemistry-I	3	0	0	3	3
2	Basic Science course	M101	Mathematics –I	4	0	0	4	4
3	Engineering Science Courses	EE101	Basic Electrical Engineering	3	0	0	3	3
4	Humanities and Social Sciences including Management courses	HSMC101	Professional Communication	2	0	0	2	2
	B. PRACTICAL							
5	Basic Science course	CH191	Chemistry-I Lab	0	0	3	3	1.5
6	Engineering Science Courses	EE191	Basic Electrical Engineering Lab	0	0	3	3	1.5
7	Engineering Science Courses	ME191	Workshop & Manufacturing Practices	0	0	3	3	1.5
8	PROJECT	PR191	Theme based Project I	0	0	1	1	0.5
9	PROJECT	PR192	Skill Development I: Soft Skill	0	0	1	1	0.5
	C. MANDATORY ACTIVITIES / COURSES*							
10	Mandatory Course	MC181	Induction Program	0	0	0	0	
	TOTAL CREDIT							17.5

*After successful completion of MC181 a student will acquire 2Units of mandatory course knowledge as mandated by AICTE.

First Year 2nd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	A. THEORY			L	T	P	Total	
1	Basic Science	PH201	Physics-I	3	0	0	3	3
2	Basic Science	M201	Mathematics –II	4	0	0	4	4
3	Engineering Science Courses	CS201	Programming for Problem Solving	3	0	0	3	3
	B. PRACTICAL							
4	Basic Science course	PH291/ CH291	Physics-I Lab	0	0	3	3	1.5
5	Humanities and Social Sciences including	HSMC291	Professional Communication LAB	0	0	3	3	1
6	Engineering Science Courses	ME292	Engineering Graphics & Design Lab	0	0	3	3	1.5
7	Engineering Science Courses	CS291	Programming for Problem Solving Lab	0	0	3	3	1.5
8	PROJECT	PR291	Theme based Project II	0	0	1	1	0.5
9	PROJECT	PR292	Skill Development II: Life Skill	1	0	0	1	0.5
	C. MANDATORY ACTIVITIES / COURSES*							
10	Mandatory Course	MC281	NSS/ Physical Activities / Meditation &Yoga / Photography/ Nature Club	0	0	3	3	0
	TOTAL CREDIT							16.5

*After successful completion of MC281 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

2nd Year 1st Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	PH(ME) 301	Physics-II	3	0	0	3	3
2	PC	ME301	Engineering Thermodynamics	3	0	0	3	3
3	PC	ME302	Manufacturing Processes	3	0	0	3	3
4	PC	ME303	Fluid Mechanics	3	0	0	3	3
5	ES	ME304	Engineering Mechanics	3	0	0	3	3
6	ES	ME305	Data Structure	2	0	0	2	2
B. PRACTICAL								
7	BS	PH(ME)391	Physics-II lab	0	0	2	2	1.0
8	ES	ME391	Machine Drawing	0	0	3	3	1.5
9	PC	ME392	Manufacturing Process Lab	0	0	3	3	1.5
10	PROJECT	PR391	Theme based Project III	0	0	1	1	0.5
11	PROJECT	PR392	Skill Development III: Technical Seminar Presentation	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES*								
12	MC	MC381	Learning an Art Form [vocal or instrumental, dance, painting, clay modeling, etc.] OR Environmental Protection Initiatives	0	0	3	0	
	TOTAL CREDIT WITHOUT MOOCS COURSES							**22**
D.MOOCS COURSES**								
13	MOOCS COURSES	HM301	MOOCS COURSE-I					
TOTAL CREDIT WITH MOOCS COURSES								**26**

*After successful completion of MC381 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

2nd Year 2nd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	HSMC (Humanities and Social Sciences including Management courses)	HSMC402	Gender Culture and Development	2	0	0	2	2
2	BS	M401	Mathematics III	3	0	0	3	3
3	ES	ME401	Materials Engineering	3	0	0	3	3
4	PC	ME402	Fluid Machinery	3	0	0	3	3
5	PC	ME403	Strength of Material	3	0	0	3	3
6	PC	ME404	Applied Thermodynamics	3	0	0	3	3
B. PRACTICAL								
7	ES	ES491	Numerical Methods Lab	0	0	2	2	1
8	PC	ME491	Material Testing Lab	0	0	3	3	1.5
9	PC	ME492	Fluid Mechanics & Fluid Machines Lab	0	0	3	3	1.5
10	PROJECT	PR491	Theme based Project IV	0	0	1	1	0.5
11	PROJECT	PR492	Skill Development IV: Soft Skill & Aptitude-I	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC401	Environmental Science	0	0	3	3	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**22**
D.MOOCS COURSES*								
13	MOOCS COURSES	HM401	MOOCS COURSE-II					
TOTAL CREDIT WITH MOOCS COURSES								**26**

*After successful completion of MC401 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

3rd Year 1st Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	HSMC	HSMC503	Universal Human Values 2: Understanding Harmony	3	0	0	3	3
2	PC	ME501	Heat Transfer	3	0	0	3	3
3	PC	ME502	Manufacturing Technology	3	0	0	3	3
4	PC	ME503	IC Engine & Hybrid Vehicles	3	0	0	3	3
5	PC	ME504	Kinematics & Dynamics of Machines	3	0	0	3	3
6	PE	ME505	Professional Elective-I A. Refrigeration and Air Conditioning B. Composite Materials C. Finite Element Analysis	3	0	0	3	3
B. PRACTICAL								
7	PC	ME591	Heat Transfer Lab	0	0	3	3	1.5
8	PC	ME592	Manufacturing Technology Lab	0	0	3	3	1.5
9	PC	ME593	Thermal Engineering Lab	0	0	3	3	1.5
10	PE	ME594	Professional Elective-I Lab A.Refrigeration and Air Conditioning Lab B.Composite Materials Lab C.Finite Element Analysis Lab	0	0	3	3	1.5
11	PROJECT	PR591	Minor Project I	0	0	3	3	1
12	PROJECT	PR592	Skill Development V: Soft Skill & Aptitude-II	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC501	Intellectual Property Right	2	0	0	2	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**25.5**
D. MOOCS COURSES**								
14	MOOCS COURSES	HM501	MOOCS COURSE-III	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**29.5**

*After successful completion of MC501 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

3rd Year 2nd Semester

Sl.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	HSMC	HSMC604	Economics for Engineers	2	0	0	2	2
2	PC	ME601	Design of Machine Elements	3	0	0	3	3
3	PC	ME602	Power Plant Engineering	3	0	0	3	3
4	PE	ME603	Professional Elective-II A. Robotics B. Computational Fluid Dynamics C. Fluid Power control	3	0	0	3	3
5	PE	ME604	Professional Elective-III A. Materials Handling B. Computer Aided Design C. Nuclear Power Generation & Supply	3	0	0	3	3
6	OE	ME605	Open Elective-I A. Mechatronics Systems B. Data Base Management System C. Electrical Machines	3	0	0	3	3
B. PRACTICAL								
7	PC	ME691	Design Lab	0	0	3	3	1.5
8	PE	ME692	Professional Elective-II Lab A. Robotics Lab B. Computational Fluid Dynamics Lab C. Fluid Power control Lab	0	0	3	3	1.5
9	OE	ME693	Open Elective-I Lab A. Mechatronics Systems Lab B. Data Base Management System Lab C. Electrical Machines Lab	0	0	3	3	1.5
10	PROJECT	PR691	Minor Project II	0	0	3	2	1
11	PROJECT	PR692	Skill Development VI: Soft Skill & Aptitude-III	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC601	Constitution of India	3	0	0	3	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D.MOOCS COURSES**								
13	MOOCS COURSES	HM601	MOOCS COURSE-IV	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.0**

*After successful completion of MC601 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

4th Year 1st Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	HSMC	HSMC705	Industrial Management	2	0	0	2	2
2	PC	ME701	Advanced Manufacturing Technology	3	0	0	3	3
3	PE	ME703	Professional Elective-IV A. Automobile Engineering B. Tribology C. Maintenance Engineering D. Turbomachinery	3	0	0	3	3
4	OE	ME704	Open Elective-II A. 3D Printing and Design B. Internet Of Things C. Biomechanics & Biomaterials D. Microprocessor in Automation	3	0	0	3	3
5	OE	ME705	Open Elective-III A. Electric Vehicles B. Industrial Instrumentation C. Operation Research D. Cyber Security	3	0	0	3	3
B. PRACTICAL								
6	PC	ME791	Advanced Manufacturing Lab	0	0	0	3	1.5
7	OE	ME792	Open Elective-I Lab	0	0	3	3	1.5
8	PROJECT	PR791	Major Project-I	0	0	0	4	2
9	PROJECT	PR792*	Industrial Training / Internship	0	0	0	0	1
10	PROJECT	PR793	Skill Development VII: Seminar & Group Discussion	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
11	MC	MC701	Entrepreneurship & Innovation Skill	2	0	0	2	0
TOTAL CREDIT WITHOUT MOOCS COURSES								**20.5**
D.MOOCS COURSES**								
12	MOOCS COURSES	HM701	MOOCS COURSE-V	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**24.5**

*After successful completion of MC781, a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

***Collective Data from 3rd to 6th Semester (Summer/Winter Training during Semester Break & Internship should be done after 5th Semester or 6th Semester). All related certificates to be collected by the training/internship coordinator(s).**

****** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET

4th Year 2nd Semester

Sl No	Course Code	Course Code	Theory	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PE	ME801	Professional Elective-V A. Renewable Energy System B. Micro and Nano Manufacturing C. Gas Dynamics & Jet Propulsion D. Design of Transmission System	3	0	0	3	3
2	OE	ME802	Open Elective-IV A. Energy Conservation & Management B. Artificial Intelligence C. Block Chain D. Nanotechnology	3	0	0	3	3
3	OE	ME803	Open Elective-V A. Total Quality Management B. Safety & Occupational Health C. Industrial Pollution and Control D. Big Data Analytics	3	0	0	3	3
B. PRACTICAL								
4	PROJECT	PR891	Major Project-II	0	0	0	12	6
5	PROJECT	PR892	Grand Viva	0	0	0	0	1
C. MANDATORY ACTIVITIES / COURSES								
6	MC	MC881	Essence of Indian Knowledge Tradition	0	0	3	3	3 Units
TOTAL CREDIT								**16**

Total Credit:

	Total for ME	
Semester	**Without MOOCS**	**With MOOCS**
1st	17.5	17.5
2nd	16.5	16.5
3rd	22	26
4th	23	27
5th	24.5	28.5
6th	23	27
7th	20.5	24.5
8th	16	16
TOTAL	**163**	**183 (for Honors/minor)**

Credit Distribution

Subject Category	Subjects	Credit Distribution as per AICTE (%)	Suggested Breakup of Credits (Total 160) as per AICTE	
Humanities and Social Sciences including Management courses (HSMC)	**Humanities & Social Science:** (i)English (ii)Language / English Lab **Management courses** (i)Gender Culture and Development, (ii)Universal Human Values 2: Understanding Harmony (iii)Economics for Engineers (iv)Industrial Management	5 to 10%	**12**	**9+3** **5.63%**
Basic Sciences (BS)	**Physics** (i)Introduction to Electromagnetic Theory (ii)Introduction to Mechanics (iii)Quantum Mechanics for Engineers (iv)Oscillation, Waves and Optics (v)Semiconductor Optoelectronics (vi)Semiconductor Physics	15 to 20%	25	**24 [IT, BME, ME, CE]** **15.00%**
	Chemistry & Biology (i)Chemistry–I (Concepts in chemistry for engineering) (ii)Chemistry Laboratory **Elective Courses** (i)Chemistry-II (Chemical Applications) (ii) Polymer Chemistry (iii)Experiments in Polymer Chemistry **Biology**			
	Mathematics **(i)Mathematics (Option 1)** Mathematics 1 Mathematics 2 Mathematics 3 **(ii)Mathematics (Option 2)** (for CSE students)			
Engineering Sciences and Skills (ES)	(i)Workshop / Manufacturing Practice (ii)Drawing/Engineering Graphics & Design, (iii) Basic Electrical Engineering (iv)Computer / Programming for Problem Solving (v)Numerical Methods (vi)Material Science	15 to 20%	**24**	**22.5** **14.06%**
Professional Core Courses (PC)	Courses relevant to chosen branch	30 to 40%	**51**	**51.0** **31.28%**
Professional Elective	Elective courses relevant to chosen specialization / branch	10 to 15%	**18**	**16.5** **13.80%**
Open Elective	Elective Courses from other technical programs and /or emerging subjects:	5 to 10%	**18**	**16.5**

	1.Artificial Intelligence (AI) 2. Internet of Things (IoT) 3. Block Chain 4. Robotics 5. Quantum Computing 6. Data Sciences 7. Cyber Security 8. 3D Printing and Design 9. Virtual Reality (VR)			**10.31%**
Project work, seminar and internship in industry or elsewhere	(i) PROJECT (PR….91): Project work (ii)PROJECT (PR….92): (iii) PROJECT (PR …93): (iv)Grand Viva - 1	10 to 15%	**15**	**17.5** **10.94%**
Mandatory Courses [Environmental Sciences, induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	**MC Courses:** (i)Environmental Science, (ii)Foreign language, (iii)Constitution of India (iv)Behavioral & Interpersonal skills (v)Essence of Indian Knowledge Tradition **& Others as mentioned in AICTE guidelines** **MC Activities:** (i)Induction Programming (ii)NSS/NCC/Yoga (iii)Technical Lecture Presentation **& others as mentioned in AICTE guidelines**	No Credit Course	Minimum 2 units per semester min. Max: 28 Units/Program	

Summary

Sub	**Credit**	**%**	**AICTE %**
HSMC	9	5.63	5 to 10
BSHU	24	15.00	15 to 20
ES	22.5	14.06	15 to 20
PC	51	31.28	30 to 40
PE	22.5	14.06	10 to 15
OE	16.5	10.31	5 to 10
Project	17.5	10.94	10 to 15
	160	**100.00**	

Professional Electives (It is expected that the Options in a vertical column would lead to expertise in a specific/allied domain)				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Professional Elective I	Refrigeration and Air Conditioning	Composite Materials	Finite Element Analysis	-
Professional Elective II	Robotics	Computational Fluid Dynamics	Fluid Power control	-
Professional Elective III	Materials Handling	Computer Aided Design	Nuclear Power Generation & Supply	-
Professional Elective IV	Automobile Engineering	Tribology	Maintenance Engineering	Turbomachinery
Professional Elective V	Renewable Energy System	Micro and Nano Manufacturing	Gas Dynamics & Jet Propulsion	Design of Transmission System
Professional Elective VI	**-**	**-**	**-**	**-**

Open Electives (It is expected that the Options in a vertical column would lead to expertise in a specific/allied domain)				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Open Elective I	Mechatronic Systems	Data Base Management System	Electrical Machines	
Open Elective II	3D Printing and Design	Internet Of Things	Operation Research	Microprocessor in Automation
Open Elective III	Electric Vehicles	Industrial Instrumentation	Biomechanics & Biomaterials	Cyber Security
Open Elective IV	Energy Conservation & Management	Artificial Intelligence	Block Chain	Nanotechnology
Open Elective V	Total Quality Management	Safety & Occupational Health	Industrial Pollution and Control	Big Data Analytics

**** For earning Honors Degree, 20 Credit point have to be earned by the student from the MOOCS Basket on the following options. (It is expected that Options in a vertical column would lead to expertise in a specific / allied domain)**

MOOCs Basket - Option 1 Honors in Design & Manufacturing						
	Sem	Credit	Option 1 Honors in Design & Manufacturing	Option 2 Honors in Automobiles & Aerospace	Option 3 Honors in Robotics	Option 4 Minor in Computer Science
MOOCS COURSE-I	III	4	Engineering Mechanics - Statics and Dynamics - 2	3D model creation with Auto desk Fusion 360 Thermodynamics & its Application– Cr 2 https://onlinecourses.swayam2.ac.in/nou23_me01/preview	Mechatronics Cr - 2 https://onlinecourses.nptel.ac.in/noc23_me50/preview	C++ For C Programmers, Part A
MOOCS COURSE-II	IV	4	Mechanics of Materials IV: Deflections, Buckling, Combined Loading & Failure Theories Nature and Properties of Materials – Cr 2 https://onlinecourses.nptel.ac.in/noc23_me17/preview	Aerospace materials Steam and Gas Power Systems – Cr 2 https://onlinecourses.nptel.ac.in/noc23_me08/preview Fundamentals of Theoretical and Experimental Aerodynamics – Cr -3 https://onlinecourses.nptel.ac.in/noc23_ae06/preview	Modern Robotics, Course 1: Foundations of Robot Motion	C++ For C Programmers, Part B
MOOCS COURSE-III	V	4	CAD/CAM Computer Aided Design / Computer Aided Manufacturing – 2 Failure analysis and Prevention – Cr 2 https://onlinecourses.nptel.ac.in/noc23_me05/preview	Flight mechanics - The basis Modelling and Simulation of Dynamic Systems– Cr 2 https://onlinecourses.nptel.ac.in/noc23_me19/preview	Modern Robotics, Course 2: Robot Kinematics	Python Programming Essentials

MOOCS COURSE-IV	VI	4	Introduction to CAD, CAM and practical CNC Machining Manufacturing Guidelines for Product Design https://onlinecourses.nptel.ac.in/noc23_me44/preview Gear And Gear Unit Design: Theory And Practice https://onlinecourses.nptel.ac.in/noc23_me37/preview	Electric Vehicles and Mobility	Modern Robotics, Course 3: Robot Dynamics	Introduction to the Internet of Things and Embedded Systems
MOOCS COURSE-V	VII	4	The 3D Printing Revolution Product Engineering and Design Thinking – Cr-2 https://onlinecourses.nptel.ac.in/noc23_me52/preview	Introduction to Self-Driving Cars	Modern Robotics, Course 5: Robot Manipulation and Wheeled Mobile Robots	AI For Everyone

MOOCs Basket						
	Sem	Credit	Option 1 Honors in Design & Manufacturing	Option 2 Honors in Automobiles & Aerospace	Option 3 Honors in Robotics	Option 4 Minor in Computer Science
MOOCS COURSE-I	III	4	Engineering Mechanics - Statics and Dynamics - 2	3D model creation with Autodesk Fusion 360	Mechatronics Cr - 2 https://onlinecourses.nptel.ac.in/noc23_me50/preview	C++ For C Programmers, Part A
MOO	I	4	Mechanics of Materials IV:	Aerosp	Modern Robotics, Course 1:	C++

CS COURSE-II	V		Deflections, Buckling, Combined Loading & Failure Theories Nature and Properties of Materials https://onlinecourses.nptel.ac.in/noc23_me17/preview	ace materials	Foundations of Robot Motion	For C Programmers, Part B
MOOCS COURSE-III	V	4	CAD/CAM Computer Aided Design / Computer Aided Manufacturing - 2	Flight mechanics - The basis	Modern Robotics, Course 2: Robot Kinematics	Python Programming Essentials
MOOCS COURSE-IV	VI	4	Introduction to CAD, CAM and practical CNC Machining	Electric Vehicles and Mobility	Modern Robotics, Course 3: Robot Dynamics	Introduction to the Internet of Things and Embedded Systems
MOOCS COURSE-V	VII	4	The 3D Printing Revolution Product Engineering and Design Thinking – Cr-2	Introduction to Self-Driving Cars	Modern Robotics, Course 5: Robot Manipulation and Wheeled Mobile Robots	AI For Everyone

Coursera Mapping			
Semester	**Primary Course Title as per curriculum**	**Mapped Coursera Course Name**	**Course Link**
3	Engineering Mechanics	**Introduction to Engineering Mechanics**	https://www.coursera.org/learn/engineering-mechanics-statics
4	Applied Thermodynamics	**Introduction to Thermodynamics: Transferring Energy from Here to There**	https://www.coursera.org/learn/thermodynamics-intro
5	Manufacturing Technology	**Digital Manufacturing & Design**	https://www.coursera.org/learn/digital-manufacturing-design
6	Design of Machine Elements	**Machine Design Part I**	https://www.coursera.org/learn/machine-design1
7	Advanced Manufacturing Technology	**3D Printing Applications**	https://www.coursera.org/learn/3d-printing-applications#syllabus
8	Open Elective-IV A. Energy Conservation & Management	**Introduction to Sustainability**	https://www.coursera.org/learn/sustainability
	B. Artificial Intelligence	**AI For Everyone**	https://www.coursera.org/learn/ai-for-everyone
	C. Block Chain	**Blockchain Basics**	https://www.coursera.org/learn/blockchain-basics
	D. Nanotechnology	**Nanotechnology: A Maker's Course**	https://www.coursera.org/learn/nanotechnology

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****For earning Minor Degree in any one of the given options, following credit points need to be earned by the student as per AICTE Recommendation.**

S. No.	Subject
1	Robotics
2	Artificial Intelligence and Machine Learning
3	Internet of Things (IoT)
4	Cyber Security
5	Virtual and Augmented Reality
6	Blockchain
7	Data Science

Detailed Syllabus in Appendix - 1

DETAILED CURRICULUM & SYLLABUS

First Year First Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	D. THEORY			L	T	P	Total	
1	Basic Science course	CH101	Chemistry-I	3	0	0	3	3
2	Basic Science course	M101	Mathematics –I	4	0	0	4	4
3	Engineering Science Courses	EE101	Basic Electrical Engineering	3	0	0	3	3
4	Humanities and Social Sciences including Management courses	HSMC101	Professional Communication	2	0	0	2	2
	E. PRACTICAL							
5	Basic Science course	CH191	Chemistry-I Lab	0	0	3	3	1.5
6	Engineering Science Courses	EE191	Basic Electrical Engineering Lab	0	0	3	3	1.5
7	Engineering Science Courses	ME191	Workshop & Manufacturing Practices Lab	0	0	3	3	1.5
8	PROJECT	PR191	Theme based Project I	0	0	1	1	0.5
9	PROJECT	PR192	Skill Development I: Soft Skill	0	0	1	1	0.5
	F. MANDATORY ACTIVITIES / COURSES*							
10	Mandatory Course	MC181	Induction Program	0	0	0	0	
	TOTAL CREDIT							17.5

*After successful completion of MC181 a student will acquire 2Units of mandatory course knowledge as mandated by AICTE.

COURSE NAME: CHEMISTRY
COURSE CODE: CH101
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Pre requisites: A basic knowledge in 10+2 science with chemistry

Course Outcomes: After successful completion of this course learners will be able to
CO1: Describe the fundamental properties of atoms & molecules, atomic structure and the periodicity of elements in the periodic table
CO2: Apply fundamental concepts of thermodynamics in different engineering applications.
CO3: Apply the knowledge of water quality parameters, corrosion control & polymers to different industries.
CO4: Determine the structure of organic molecules using different spectroscopic techniques.
CO5: Evaluate theoretical and practical aspects relating to the transfer of the production of chemical products from laboratories to the industrial scale, in accordance with environmental considerations.

Course Content

Module- I: Inorganic Chemistry 9L
(i) Atomic structure 5L
Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers, Introduction to the concept of atomic orbitals, diagrams of s, p and d orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation, introduction to Schrodinger equation.
(ii) Periodic properties 4L
Modern Periodic table, group trends and periodic trends in physical properties: electron affinity, electronegativity, polarizability, oxidation states, effective nuclear charges, penetration of orbitals, variations of s, p and d orbital energies of atoms.

Module II: Physical Chemistry 8L
(i) Use of free energy in chemical equilibria 6L
Thermodynamic functions: internal energy, enthalpy, entropy and free energy. 2nd Law of Thermodynamics, Estimations of entropy and free energies, Free energy and emf, Cell potentials, the Nernst equation and applications.
(ii) Real Gases 2L
Reason for deviation of real gases from ideal behavior, Equations of state of real gases, Vander Waals' equation, pressure & volume correction, validity, critical state of gas.
Module III: Organic Chemistry 8L
(i) Stereochemistry 4L
Representations of 3 dimensional structures, Chirality, optical activity, isomerism, structural isomerism, stereoisomers, enantiomers, diastereomers, configurations (D,L & cis trans), racemization.
(ii) Organic reactions 4L

Concepts of inductive effect, resonance, hyperconjugation, introduction to reactions involving substitution, addition, elimination, oxidation (Baeyer villager oxidation), reduction (Clemmensen reduction, Wolff-Kishner reduction).

Module IV: Industrial Chemistry **8L**

(i) Water **2L**

Hardness, alkalinity, numerical

(ii) Corrosion. **2L**

Types of corrosion: wet & dry, preventive measures

(iii) Polymers **3L**

Classification of polymers, conducting polymers, biodegradable polymers

(iv) Synthesis of a commonly used drug molecule. **1L**

Paracetamol, Aspirin

Module V: Spectroscopic techniques in Chemistry **3L**

Electromagnetic radiation, Principles of spectroscopy, spectrophotometer, infrared spectroscopy, fingerprint region, functional group region, UV-VIS spectroscopy, ^{1}H Nuclear magnetic resonance spectroscopy, chemical shift.

Project Domain

1. Application of Thermodynamics
2. Application of polymers in daily life
3. Nanomaterials and its applications
4. Determination of water quality parameters
5. Electronic storage devices
6. Managing E –wastes
7. Application of chemistry in core engineering
8. Application of spectroscopy in medical field
9. Applications of green chemistry
10. Merits of commercial organic products
11. Bioplastics
12. Any other related topics

Text Books

1. A Text Book of Organic Chemistry, Arun Bahl& Arun Bahl
2. General & Inorganic Chemistry, P.K. Dutt
3. General & Inorganic Chemistry, Vol I, R.P. Sarkar
4. Physical Chemistry, P.C. Rakshit

Reference Books

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
2. Fundamentals of Molecular Spectroscopy, by C. N.Banwell
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
4. Physical Chemistry, by P. W.Atkins
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Editionhttp://bcs.whfreeman.com/vollhardtschore5e/default.asp

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	-	-	-	-	2	2	2	2	1	-	-
CO2	3	3	3	3	-	-	-	-	2	2	2	3	1	2	-
CO3	3	3	2	2	-	2	2	-	2	-	3	3	2	-	-
CO4	3	2	3	2	-	-	2	-	2	2	3	3	1	2	-
CO5	3	3	3	3	2	2	2	-	2	-	2	3	2	2	-

COURSE NAME: MATHEMATICS-I
COURSE CODE: M101
CONTACT: 3:1:0
TOTAL CONTACT HOURS: 48
CREDITS: 4
Prerequisite: The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra, calculus and vector algebra.

Course Outcomes (COs): After successful completion of this course learners will be able to
CO1: Recall the properties and formula related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.
CO2: Determine the solutions of the problems related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.
CO3: Apply the appropriate mathematical tools of matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series for the solutions of the problems.
CO4: Analyze different engineering problems linked with matrix algebra, differential calculus, multivariable calculus, vector calculus.

Course Content:

Module I: Matrix Algebra **11L**
Echelon form and Normal (Canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton theorem.

Module II: Differential Calculus and Infinite Series **10L**
Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Concept of sequence and series, Tests for convergence of infinite series: Comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Leibnitz's Test, Power series; Taylor's series, Series for exponential, trigonometric and logarithm functions.

Module III: Multivariable Calculus (Differentiation) **13L**
Function of several variables, Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; Chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function, Jacobian. Maxima and minima of functions of two variables, Method of Lagrange multipliers.

Module IV: Multivariable Calculus (Integration) **6L**
Line Integral, Double Integral, Triple Integral,Change of order in multiple integrals, Change of variables in multiple integrals.

Module V: Vector Calculus **8L**
Gradient, Directional derivatives, Divergence, Curl, vector line integrals, vector surface integrals, vector volume integrals, Green's theorem, Gauss divergence theorem and Stokes' theorem.

Project Domain:

1. Study on eigenvalues and eigenvectors.
2. Study on convergence of infinite series.
3. Application of partial derivatives.
4. Application of vector calculus
5. Application of integral calculus.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics-I, New age International Publishers

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
3. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
4. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
6. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969

CO-PO Mapping:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	POS 1	PSO 2	PSO 3
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**
CO3	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**
CO4	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

COURSE NAME: BASIC ELECTRICAL ENGINEERING
COURSE CODE: EE101
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Pre-requisite: Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

Course Outcomes:
CO1: To understand and analyze basic electric circuits
CO2: To study the working principles of electrical machines.
CO3: To introduce the components of low voltage electrical installations
CO4: To study the fundamentals of electrical Power systems and Control Systems

Course Content

Module- I: DC Circuits **8L**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, active and passive elements, Kirchhoff's laws, Source equivalence and conversion, Network Theorems - Superposition Theorem, Thevenin's Theorem, Norton Theorem, Maximum Power Transfer Theorem, Star-Delta Conversions.

Module- II: AC Fundamentals **8L**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Module- III: Electrical Machines **10L**

Transformer: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.
Rotating Machines - DC Machines: Brief idea on constructional features, classifications, working principle of both motor and generator. Simple problems on Voltage equation. Three-Phase Induction Motor: Basic concept of three phase circuit and production of rotating magnetic field. Working principle of three-phase induction motor and torque-speed characteristics (concept only).

Module- IV: Electrical Installations **3L**

Earthing of Electrical Equipment, ideas of basic components- MCB, MCCB, ELCB, SFU, Megger. Types of Wires and Cables, Earthing.

Module- V: Fundamentals of Power Systems **5L**

Generation of power: Block schematic representation of Thermal and nuclear power plants. Renewable energy sources: solar, wind, tidal and geothermal (Block diagram and working only-No Problems). Power transmission: Typical electrical power transmission scheme-need for high

voltage transmission-(Derivation is not needed, No Problems). Power Distribution: substation equipments, primary and secondary transmission and distribution systems- feeder, service mains.

Module- VI: Introduction to Control Systems **2L**

Concept control systems, Objectives of control system, Types of control systems, Real examples of control systems.

Text books:

D. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.

1. V. Mittle& Arvind Mittal, Basic Electrical Engineering, TMH.
2. Ashfaq Hussain, Basic Electrical Engineering, S. Chand Publication.
3. Chakrabarti, Nath& Chanda, Basic Electrical Engineering, TMH.
4. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education.

Reference books:

1. E. Hughes, ―Electrical and Electronics Technology‖, Pearson, 2010.
2. V. D. Toro, ―Electrical Engineering Fundamentals‖, Prentice Hall India, 1989.

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	-	-	-	-	-	-	-	-	2	-	1	2
CO2	2	2	2	-	-	-	-	-	-	-	-	2	-	1	2
CO3	-	2	2	-	-	-	-	-	-	-	-	2	-	1	2
CO4	-	2	-	-	-	-	-	-	-	-	-	2	-	1	2

COURSE NAME: PROFESSIONAL COMMUNICATION
COURSE CODE: HSMC101
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 28
CREDITS: 2
Pre-requisites: Basic (10+2) level of knowledge of English grammar, vocabulary reading and writing skills.

Course Outcomes: After successful completion of this course learners will be able to
CO1: Understand about and use the modalities and nuances of communication in a workplace context.
CO2: Understand about communicating across cultures and societies.
CO3: Know about and apply the basic formats, templates of business and official communication.
CO4: Know about and employ formal communication modes in meetings and reports.
CO5: Know about and use objective and culturally neutral language in interpersonal and business communication.

Course Content:

Module- 1: Verbal and Non-verbal communication **4L**
1.1: Definition, Relevance and Effective Usage
1.2: Components of Verbal Communication: Written and Oral Communication
1.3: Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics Paralanguage
1.4: Barriers to Effective Communication

Module- 2: Social Communication Essentials and Cross-Cultural Communication **6L**
2.1: Communication in Society and the Workplace
2.2: Greetings, Courtesies and Socially Useful Language
2.3: Cultural Contexts: High Context and Low Context Cultures
2.4: Understanding Cultural Nuances and Stereotyping
2.5: Achieving Culturally Neutral Communication in Speech and Writing

Module- 3: Meetings **4L**
3.1: Meetings: Nature and Types
3.2: Conducting Meetings: Organization and Procedures
3.3: Meeting Coordination: Roles of Chairpersons and Members
3.4: Notice and Agenda for a Meeting
3.5: Preparing the Minutes of a Meeting (MOM)

Module- 4: Report Writing **4L**
4.1: Nature and Function of Reports
4.2: Types of Reports
4.3: Researching for a Business Report
4.4: Format, Language and Style
4.5: Report Documentation

Module 5: Employment Communication **10L**
5.1: Writing Business Letters- (Enquiry, Order, Sales, Complaint, Adjustment, Job Application, Offer)
5.2: Preparing a CV or Rĕsumĕ

5.3: Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)
5.4: Writing E-mails: types, convention, and etiquette
5.5: Memo, Notices and Circulars
5.6: Writing Technicalities—Paragraphing, Sentence Structure and Punctuation

Text Books &Reference Books:

1. Meenakshi Raman and Sangeetha Sharma. *Technical Communication*. 3rd edition. New Delhi: Oxford University Press, 2015.
2. Mark Ibbotson. *Cambridge English for Engineering*. Cambridge: Cambridge University Press, 2008.
3. Mark Ibbotson. *Professional English in Use: Engineering*. Cambridge: Cambridge UP, 2009.
4. Lesikar et al. *Business Communication: Connecting in a Digital World*. New Delhi: Tata McGraw-Hill, 2014.
5. John Seeley. *Writing Reports*. Oxford: Oxford University Press, 2002.
6. Judith Leigh. *CVs and JobApplications*. Oxford: Oxford University Press, 2002.
7. Judith Leigh. *Organizing and Participating in Meetings*. Oxford: Oxford University Press, 2002.
8. Michael Swan. *Practical English Usage*. Oxford: OUP, 1980.
9. Pickett, Laster and Staples. *Technical English: Writing, Reading & Speaking.* 8th ed. London: Longman, 2001.
10. Diana Booher. *E-writing: 21st Century Tools for Effective Communication*.

Links:

1. Purdue University's Online Writing Lab (OWL)-https://owl.purdue.edu/
2. Business English Pod-https://www.businessenglishpod.com/

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	2	-	-	3	-	2	-	2	3
CO2	2	3	2	-	-	2	2	2	-	3	-	3	-	2	3
CO3	2	3	-	-	-	3	3	3	-	3	-	3	-	2	3
CO4	-	-	-	-	-	3	3	3	-	3	-	3	-	2	3
CO5	-	-	-	-	-	-	3	3	-	3	-	3	-	2	3

COURSE NAME: CHEMISTRY LAB
COURSE CODE: CH191
CONTACT: 0:0:3
CREDITs: 1.5
Pre-requisite: A basic knowledge in 10+2 science with chemistry.
Course Outcome: After successful completion of this course learners will be able to
CO1: Operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
CO2: Analyze and determine the composition of liquid and solid samples working as an individual and also as a team member.
CO3: Analyze different parameters of water considering environmental issues.
CO4: Synthesize drug and polymer materials.
CO5: Design innovative experiments applying the fundamentals of chemistry.

Course Content:
Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Determination of hardness of water
4. Determination of chloride content of water
5. Determination of the rate constant of a reaction
6. Determination of cell constant and conductometric titration
7. pH metric titrations
8. Synthesis of a polymer/drug
9. Saponification/acid value of an oil
10. Chemical analysis of a salt
    Chemical oscillations- Iodine clock reaction
11. Determination of the partition coefficient of a substance between two immiscible liquids
12. Adsorption of acetic acid by charcoal
13. Estimation of iron in Mohr's salt solution by permanganometry (Redox Titration)
14. Innovative experiments (any one)
    - Synthesis of silver nano-particles
    - Green synthesis

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	-	2	3	-	-	-	-	2	1	-	-
CO2	2	2	2	2	-	2	-	-	-	2	-	2	1	2	-
CO3	-	-	-	-	-	-	-	-	3	3	2	2	2	-	-
CO4	2	2	2	2	-	-	2	-	-	-	-	2	1	2	-
CO5	3	3	3	3	2	2	2	2	-	-	2	2	2	2	-

COURSE NAME: BASIC ELECTRICAL ENGINEERING LABORATORY
COURSE CODE: EE191
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisite: Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

Course Outcome: After successful completion of this course learners will be able to
CO1: Identify and use common electrical components.
CO2: To develop electrical networks by physical connection of various components and analyze the circuit behavior.
CO3: Apply and analyze the basic characteristics of transformers and electrical machines.

List of Experiments

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Verification of Thevenin's and Norton's Theorem.
3. Verification of Superposition and Maximum Power Transfer Theorem.
4. Characteristics of Fluorescent, Tungsten and Carbon filament lamps.
5. Study of R-L-C series circuit.
6. Three-phase Power measurement with two wattmeter methods.
7. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
8. Measurement of primary and secondary voltage and current of single-phase transformer – Open Circuit and Short Circuit Test.
9. Starting, Reversing and speed control of DC shunt motor.
10. Torque-Speed characteristics of DC Machine.
11. Torque-Speed characteristics of Three-phase Induction Motor.
12. Test on single-phase Energy Meter.
13. Innovative experiments

CO-PO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	2	-	-	-	-	-	-	2	-	-	2	-	2	1
CO2	-	2	2	2	-	-	-	-	2	-	-	2	-	2	2
CO3	-	2	-	2	-	-	-	-	2	-	-	2	-	2	2

COURSE NAME: WORKSHOP & MANUFACTURING PRACTICES
COURSE CODE: ME191
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisite: Physics & Mathematics (10+2 Level)

Course Outcomes:
After successful completion of this course learners will be able to
CO1: Identify and operate various hand tools related to variety of manufacturing operations
CO2: Safely fabricate simple components with their own hands.
CO3: Get practical knowledge of the dimensional accuracies and tolerances applicable for different manufacturing processes.
CO4: Produce small devices of their interest for project or research purpose.

Course Content:
(i) Theoretical discussion & videos: 3P
1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing
8. Plastic moulding & Glass Cutting

(ii) Workshop Practice:

Module 1 - Machine shop 6P
Typical jobs that may be made in this practice module:
i. To make a pin from a mild steel rod in a lathe.
ii. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.
Module 2 - Fitting shop 6P
Typical jobs that may be made in this practice module:
i. To make a Gauge from MS plate.
Module 3 - Carpentry 6P
Typical jobs that may be made in this practice module:
i. To make wooden joints and/or a pattern or like.
Module 4 - Welding shop (Arc welding 3P + gas welding 3P) 3P
Typical jobs that may be made in this practice module:
i. ARC WELDING (3P): To join two thick (approx 5mm) MS plates by manual metal arc welding.
ii. GAS WELDING (3P): To join two thin mild steel plates or sheets by gas welding.
Module 5 - Electrical & Electronics 3P
House wiring, soft Soldering
Module 6 – Smithy 3P

Typical jobs that may be made in this practice module:
i. A simple job of making a square rod from a round bar or similar.
For further study (Optional)

Module 7 - Casting **3P**

Typical jobs that may be made in this practice module:
i. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 8 - Plastic moulding & Glass Cutting **3P**

Typical jobs that may be made in this practice module:
i. For plastic moulding, making at least one simple plastic component should be made.
ii. At least one sample shape on glass should be made using laser cutting machine.
Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1.Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2.Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. and Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A. Ghosh and A.K. Mallick, Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C. Sen and A. Bhattacharya, New Central Book Agency, Kolkata.

CO-PO Mapping:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	2	-	2	3	-	-	2	2	2	3	3	3	2
CO2	1	-	3	1	2	2	2	-	3	2	2	3	2	2	2
CO3	2	2	2	1	2	2	-	2	2	2	2	3	2	2	2
CO4	2	2	3	1	3	3	2	-	3	2	3	3	2	2	3

First Year 2nd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	A. THEORY			L	T	P	Total	
1	Basic Science	PH 201	Physics-I	3	0	0	3	3
2	Basic Science	M 201	Mathematics –II	4	0	0	4	4
3	Engineering Science	CS 201	Programming for Problem	3	0	0	3	3
	B. PRACTICAL							
4	Basic Science course	PH 291/ CH 291	Physics-I Lab	0	0	3	3	1.5
5	Humanities and Social Sciences including Management	HSMC291	Professional Communication LAB	0	0	3	3	1
6	Engineering Science Courses	ME 292	Engineering Graphics & Design Lab	0	0	3	3	1.5
7	Engineering	CS 291	Programming for Problem	0	0	3	3	1.5
8	PROJECT	PR291	Theme based Project II	0	0	1	1	0.5
9	PROJECT	PR292	Skill Development II: Life Skill	1	0	0	1	0.5
	C. MANDATORY ACTIVITIES / COURSES*							
10	Mandatory Course	MC281	NSS/ Physical Activities / Meditation &Yoga / Photography/ Nature Club	0	0	3	3	0
	TOTAL CREDIT							16.5

*After successful completion of MC281 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

Paper Name: Physics –I
Paper Code: PH201
Total Contact Hours: 36
Credit: 3
Weekly load: 3L

Pre requisites: Knowledge of Physics up to 12^{th} standard.

Course Objective: The aim of courses in Physic-I is to provide adequate exposure and develop insight about the basic principles of physical sciences and its practical aspects which would help engineers to learn underlying principles of various tools and techniques they use in core engineering and related industrial applications. The course would also inculcate innovative mindsets of the students and can create awareness of the vital role played by science and engineering in the development of new technologies.

Course Outcome (CO) At the end of the course students' should be able to

CO1 : describe various types vibrating systems and their electrical equivalence and define all relevant parameters associated with crystallographic structures.

CO2: classify and compare different types of diffractions phenomena, explain basic principles of Laser, Optical fibers, and Polarization of light.

CO3: apply superposition principle to explain the origin of Lissjous figures, construct the new mechanics for the microscopic world and apply that to explain Lasing actions

CO4: analyze different crystallographic structures according to their co-ordination number and packing factors, examine the prospects of light pasting through a fiber as well as discover the success of Quantum Mechanics in several microscopic phenomena.

CO5: access the need of a quantum mechanics as a remedy to overcome limitations imposed by classical physics, evaluate the importance of polarization phenomena in areas like modern display systems and justify applications of crystallography in explaining physics of semiconductors

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	1	0	2	-	-	-	-	-	2
CO2	2	-	-	1	0	0	-	-	-	-	-	2
CO3	2	2	-	0	0	0	-	-	-	-	-	1
CO4	2	2	-	2	0	2	-	-	-	-	-	1
CO5	2	2	-	2	0	2	-	-	-	-	-	1
PH101/ PH201	2	2	-	1	0	1	-	-	-	-	-	1.4

Module 1 (5L):-
Waves & Oscillations:-
Simple Harmonic Motion (Recap), superposition of waves, damped harmonic motion-over damped, critically damped and under damped motion, energy decay, logarithmic decrement, force vibration and resonance (amplitude, velocity resonance), sharpness of resonance, quality factor, related numerical problems. 5L

Module 2 (12L):-
Classical Optics:
2.01- Interference of light: Huygens's principle, conditions of sustained interference, classification of interference, Newton's ring (qualitative descriptions of working principles and procedures-no deduction required). Engineering applications, related numerical problems. 4L

2.02- Diffraction of light: Fresnel and Fraunhofer class, Fraunhoffer diffraction of a single slit, double slit, multiple slits, intensity distributions, missing order, Rayleigh criterion (no deduction) and resolving power of grating and microscope (no deduction), related numerical problems.
4L

2.03- Polarization: Definition, Plane of polarization, Plane of vibration, Malus Law, Fundamental concepts of plane, circular & elliptical polarizations (only qualitative idea) with examples, Brewster's law, Double refraction: Ordinary & Extra ordinary rays, positive and negative crystal, Nicol's prism, Numerical problems 4L

Module 3 (8L):-
Quantum Mechanics-I
3.01 Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment.

3.02 Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions; uncertainty principle, relevant numerical problems. Introduction of Schrödinger wave equation (only statement).
4L

Module 4 (3L):-
Solid State Physics-I:
4.01 Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices –Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L

Module 5 (8L):
Modern Optics-I:
5.01- Laser: Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 5L

5.02-Fibre optics-Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

Recommended Text Books for Physics I (PH 101):

Waves & Oscillations:
1. Sound-N. K. Bajaj (TMH)
2. Advanced Acoustics-D. P. Roy Chowdhury (Chayan Publisher)
3. Principles of Acoustics-B.Ghosh (Sridhar Publisher)
4. A text book of sound-M. Ghosh (S. Chand publishers)
5. A text book of Light- K.G. Mazumder & B.Ghoshs, (Book & Allied Publisher)
6. Physics of Oscillations and Waves- R.P. Singh
7. College Physics Vol. II - A.B. Gupta
8. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:
1. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
2. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers)
3. Modern Optics-A. B. Gupta (Book & Allied Publisher)
4. Optics-Ajay Ghatak (TMH)
5. Optics-Hecht
6. Optics-R. Kar, Books Applied Publishers
7. Physical Optics Möler
8. Optics -F.A. Jenkins and H.E White

Quantum Mechanics-I
1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde and Singh (S. Chand Publishers)
3. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
4. Quantum Mechanics-Binayak Datta Roy (S. Chand Publishers)
5. Quantum Mechanics-Bransden (Pearson Education Ltd.)
6. Perspective of Modern Physics-A. Beiser (TMH)
7. Quantum mechanics -A.K. Ghatak and S Lokenathan
8. Modern Physics -E.E. Anderson
9. Physics Volume 2 -Haliday, Resnick & Krane, Published by Wiley India

Solid State Physics-I:
1. Solid state physics-Puri & Babbar (S. Chand publishers)
2. Materials Science & Engineering-Kakani Kakani
3. Solid state physics- S. O. Pillai
4. Introduction to solid state physics-Kittel (TMH)
5. Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)
6. Problem in Solid state physics -S.O. Pillai (a. b.)

Text Books:
1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics-Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Perspective & Concept of Modern Physics -Arthur Baiser
4. Principles of engineering physics – Md. N Khan and S Panigrahi.

5. Basic Engineering Physics-Sujoy Bhattacharya, Saumen Pal (MG)
6. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers)
7. Engineering Physics-A. S. Vasudeva

**Total marks of the questions set from each module should be in proportion to the number of lectures allotted.

Course Transaction Methods:

1. Flipped teaching
2. Project based learning method
3. Demonstration [A method of instruction where the instructor by performing an operation or doing a job shows the students what to do, how to do it, and through explanations brings out why, where, and when it is done]
4. Role playing
5. Think-Pair-Share
6. ICT enable teaching
7. Video based teaching
8. Experiential learning technique
9. MOOCs
10. Lecture Method
11. Discussion Method [group discussion techniques are used to reach instructional objectives]
12. Seminar/Tutorial/assignment
13. The Buzz Group (To develop and express imaginative ideas, opinions; stimulate thinking)
14. Brainstorming (Discover new ideas, thoughts and responses very quickly)

COURSE NAME: MATHEMATICS-II
COURSE CODE: M201
CONTACT: 3:1:0
TOTAL CONTACT HOURS: 48
CREDIT: 4
Prerequisite: The students to whom this course will be offered must have the concept of (10+2) calculus.

Course Outcomes (COs):
On successful completion of the learning sessions of the course, the learner will be able to
CO1: Recall the properties and formula related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.
CO2: Determine the solutions of the problems related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.
CO3: Apply appropriate mathematical tools of ordinary differential equations, improper integral, Laplace transform and numerical techniques for the solutions of the problems.
CO4: Analyze engineering problems by using differential equation, Laplace Transform and Numerical Methods.

Course Content:

Module I: First Order Ordinary Differential Equations (ODE): 10L
Solution of first order and first-degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation, Solution of first order and higher degree ODE: solvable for p, solvable for y solvable for x and Clairaut's equation.

Module II: Second Order Ordinary Differential Equations (ODE): 10L
Solution of second order ODE with constant coefficients: C.F. & P.I., Method of variation of parameters, Cauchy-Euler equations, Solution of simultaneous linear ODEs.

Module III: Laplace Transform (LT): 14L
Improper integrals; Beta and Gamma functions and their properties.
Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $t\,f\,(t)$, LT of $\frac{f\,(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties, Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT.

Module IV: Numerical Methods 14L
Introduction to error analysis, Calculus of finite difference. **Interpolation:** Newton forward and backward interpolation, Lagrange's interpolation, Newton's divided difference interpolation formula. **Numerical integration:** Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule. **Numerical solution of ordinary differential equation:** Euler method, Modified Euler method, Fourth order Runge-Kutta method.

Project Domains:

1. Mathematical modeling using ODE.
2. Application of ODE.
3. Application of Laplace Transform in different engineering branches.
4. Application of Numerical Methods in different engineering branches.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics-II, New age International Publishers
7. Mollah, S. A, Numerical Analysis and Computational Procedures, Books and Allied (P) Ltd.

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Boyce, W. E. and DiPrima, R. C., Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
3. Ross, S. L., Differential Equations, 3rd Ed., Wiley India, 1984.
4. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.
5. Coddington, E. A., An Introduction to Ordinary Differential Equations, Prentice Hall, India, 1995.
6. Dey, Sukhendu, Gupta Sisir, Numerical Methods, MsGraw Hill Education (India) Private Limited.
7. Jain, M. K., Iyengar, S. R. K., Jain, R. K., Numerical Methods, New age International Publishers

CO-PO Mapping:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**-**
CO3	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**-**
CO4	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**

COURSE NAME: PROGRAMMING FOR PROBLEM SOLVING
COURSE CODE: CS201
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisites: Number system, Boolean Algebra

Course Outcomes:
After successful completion of the course learners will be able to
CO1: Understand the fundamental concept of Computer and mathematical knowledge and apply them in designing solution to engineering problem.
CO2: Understand the basic concept of C programming and use of data types/operators/input/output function for developing and implementing complete program leading to solution of mathematical and engineering problem.
CO3: Use conditional branching, iteration, recursion and formulate algorithms and programs in solving mathematical/ scientific/ engineering problem leading to lifelong learning.
CO4: Understand the concept of arrays, pointers, file and dynamic memory allocation and apply it for problem solving and also create new data types using structure, union and Enum.
CO5: Understand how to decompose a problem into functions and assemble into a complete program by means of modular programming possibly as a team.

Course Content:

Module-1: Fundamentals of Computer **9L**

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices.
Number System: basic of Binary, Octal, Decimal and Hexadecimal number systems; Representation and interchanging of number in different number systems. Introduction to complements system, Representation of signed and unsigned numbers in singed magnitude singed 1's complement system and signed 2's complement system.
Arithmetic– Addition and Subtraction (using1'scomplementand2'scomplement).
Representation of Characters-ASCII Code
Basics of Compiler, Interpreter and Assembler
Problem solving – Basic concept of Algorithm. Representation of algorithm using flow chart and pseudo code. Some basic examples.

Module-2: Introduction to C Programming **5L**

Overview of Procedural vs Structural language; History of C Programming Language.
Variable and Data Types: The C characterse identifiers
And keywords, data type & sizes, variable names, declaration, statements.
Operators & Expressions: Arithmetic operators,relational operators, logical operators, increment anddecrementoperators,bitwiseoperators,assignmentoperators,conditionaloperators,specialoperators-typeconversion, C expressions, precedence and associativity.
Input and Output: Standard input and output, formatted output–print f,formatted input scan f.

Module-3: Branch and Loop **5L**

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else

ladder.
Switch Case: break andcontinue; switch-case, concept of goto and labels
Loops - while, for, do while

Module-4: Program Structures **4L**

Function: Basics of Functions, function types, function prototypes, formal and actual parameter, function calling, functions returning values, functions not returning values. Recursion and Recursive Function.
Storage Class in C: Storage Class-auto, external, static and register storage class, scope rules and life time of variables
C pre-processor: Pre-processing directive and macro, parameterized macro.

Module-5: Array and Pointer **7L**

Arrays: One dimensional arrays, Two-dimensional arrays, Passing an array to a function
Pointers: Pointers, Pointer andArray, Pointer and functions.
Strings: Character array and string, array of strings, Passing a string to a function, String related functions, Pointer and String.
Dynamic memory allocation: Malloc, calloc, realloc and free with example.

Module-6: Structures, Unions and Enum **3L**

Basic of structures, arrays of structures, structures and pointers, bit fields. Basics of union and enum, difference between structure and union.

Module-7: File in C **3L**

Files handling- opening and closing a file in different mode, formatted and unformatted files, Command line arguments, f open, f close, f get c, f put c, f print f, f scan f function.

Textbook:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. KanetkarY.-LetusC,BPBPublication,15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

CO–PO Mapping:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO2	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**
CO3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**
CO4	**3**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO5	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**3**	**2**	**2**

Paper Name: Physics I Lab
Paper Code: PH 191/PH 291
Total Contact Hours: 3 P/Week
Credit: 1.5

Pre requisites: Knowledge of Physics up to 12th standard.

Course Objective:

The aim of courses in Physic-I lab is to provide an adequate exposure and develop insight about the basic principles of physical sciences and its practical aspects which would help engineers to learn underlying principles of various tools and techniques they use in core engineering and related industrial applications. They course would also inculcate innovative mindsets of the students and can create awareness of the vital role played by science and engineering in the development of new technologies.

Course Outcome of Physics-I practical (PH 291)

At the end of the course students' will be able to

CO.1 : demonstrate experiments allied to their theoretical concepts
CO.2 : conduct experiments using LASER, Optical fiber, Torsional pendulum, Spectrometer
CO.3 : participate as an individual, and as a member or leader in groups in laboratory sessions actively
CO.4 : analyze experimental data from graphical representations , and to communicate effectively them in Laboratory reports including innovative experiments

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		-	-	-	-	-	-	-	-	-	2
CO2	2	2	-	2	-	-	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	3	-	-	2
CO4	2	2	-	-	2	-	-	-	-	3	-	2
PH191/ PH 291	2	2	-	2	2	-	-	-	3	3	-	2

General idea about Measurements and Errors (One Mandatory):

i) Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.
ii) Proportional error calculation using Carrey Foster Bridge.

<u>Any 6 to be performed from the following experiments</u>

Experiments on Waves & Oscillations:
1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of elastic moduli of different materials (Young's modulus /Rigidity modulus)
3. Determination of Q factor using LCR Circuit.

4. Calibration of an oscillator using Lissajous Figure.

Experiments on Classical Optics:
5. Determination of wavelength of light by Newton's ring method.
6. Determination of wavelength of light by Laser diffraction method.
7. To determine the angle of optical rotation of a polar solution using polarimeter

Experiments on Quantum Physics-I:
8. Determination of Planck's constant using photoelectric cell.
9. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
10. Determination of Stefan's Constant

In addition it is **recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment

Probable experiments beyond the syllabus:
1. Determination of wavelength of light by Fresnel's bi-prism method (beyond the syllabus).
3. Study of dispersive power of material of a prism.
4. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.
5. Measurement of nodal and antipodal points along transmission wire and measurement of wavelength.
6. Any other experiment related to the theory**.**

Recommended Text Books for Physics I Lab (PH 291):

Waves & Oscillations:
1. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:
1. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)

Quantum Mechanics-I
1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)

Solid State Physics-I:
1. Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)

Text Books:
1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing)
3. Practical Physics by R. K. Kar (Book & Allied Publisher)

COURSE NAME: PROFESSIONAL COMMUNICATION LAB
COURSE CODE: HSMC291
CONTACT: 0:0:3
TOTAL CONTACT HOURS: 26
CREDIT: 1
Pre requisites: Basic knowledge of LSRW skills.

Course Outcome: After successful completion of the course learners will be able to
CO1: understand advanced skills of Technical Communication in English through Language Laboratory.
CO2: apply listening, speaking, reading and writing skills in societal and professional life.
CO3: demonstrate the skills necessary to be a competent Interpersonal communicator.
CO4: analyze communication behaviors.
CO5: adapt to multifarious socio-economical and professional arenas with the help of effective communication and interpersonal skills.

Course Content:

Module- 1: Introduction to the Language Lab
a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book

Module- 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Academic Listening vs Business Listening
d. Listening in Business Telephony
e. Study of Contextualized Examples based on Lab Recordings

Module- 3: Speaking
a. Speaking—Accuracy and Fluency Parameters
b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities—Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
f. Business Meetings and Sales Talks

Module- 4: Lab Project Work
a. Making a brief Advertisement video (1-2 minutes)
b. Making a brief Business Documentary film (5-7 minutes)
c. Client interaction video (5-7 minutes)
d. Making a short video CV (1-2 minutes)

References:

1. IIT Mumbai, Preparatory Course in English syllabus
2. IIT Mumbai, Introduction to Linguistics syllabus
3. Sasikumar et al. A Course in Listening and Speaking. New Delhi: Foundation Books, 2005.
4. Tony Lynch, Study Listening. Cambridge: Cambridge UP, 2004.

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**2**	**-**	**2**	**3**
CO2	**2**	**3**	**2**	**-**	**-**	**2**	**2**	**2**	**-**	**3**	**-**	**3**	**-**	**2**	**3**
CO3	**2**	**3**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**2**	**3**
CO4	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**2**	**3**
CO5	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**2**	**3**

COURSE NAME: ENGINEERING GRAPHICS & DESIGN
COURSE CODE: ME292
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisites: Basic knowledge of geometry

Course Outcomes:
After successful completion of this course learners will be able to
CO1: Get introduced with Engineering Graphics and visual aspects of design.
CO2: Know and use common drafting tools with the knowledge of drafting standards.
CO3: Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints.
CO4: Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.

List of Drawing:

Traditional Engineering Graphics:
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing
Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic & Isometric Projections
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module 3: Sections and Sectional Views of Right Angular Solids
Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics:
Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics
Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering
Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerancing; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation,
CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project
Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**-**	**2**	**2**	**2**	**2**	**3**	**2**	**2**
CO2	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**
CO3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**-**	**2**	**2**	**2**	**3**	**3**	**2**	**2**
CO4	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

COURSENAME: PROGRAMMING FOR PROBLEM SOLVING LAB
COURSE CODE: CS291
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisites: Number system, Boolean Algebra

Course Outcomes:
After successful completion of this course learners will be able to
CO1: Understand and propose appropriate command or function in running system or developing program for engineering and mathematical problems depending on the platform used even in changed environment leading to their lifelong learning.
CO2: Identify and propose appropriate data type, arithmetic operators, input/output functions and also conditional statements in designing effective programs to solve complex engineering problem using modern tools.
CO3: Design and develop effective programs for engineering and mathematical problems using iterative statements as well as recursive functions using modular programming approach possibly as a team maintaining proper ethics of collaboration.
CO4: Explain and organize data in arrays, strings and structures and manipulate them through programs and also define pointers of different types and use them in defining self-referential structures and also to construct and use files for reading and writing to and from leading to solution of engineering and mathematical problem.
CO5: Prepare laboratory reports on interpretation of experimental results and analyze it for validating the same maintaining proper ethics of collaboration.

Course Content:

Module-1: Familiarization with some basic commands of DOS and Linux. File handling and Directory structures, file permissions, creating and editing simple C program in different editor and IDE, compilation and execution of C program. Introduction to Code block.
Module-2: Problem based on
a) Basic data types
b) Different arithmetic operators.
c) Print f( ) and scan f( ) functions.
Module-3: Problem based on conditional statements using
a) if-else statements
b) different relational operators
c) different logical operators
Module-4: Problem based on
a) **for** loop
b) **while** loop
c) **do-while** loop
Module-5: Problem based on
a) How to write a menu driven program using **switch-case** statement
b) How to write a function and passing values to a function
c) How to write a **recursive function.**
Module-6: Problem based on
a) How to use **array (both I-Dand2-D).**

b) How to pass an **array** to a **function.**

Module-7: Problem based on manipulation of strings in different way.

Module-8: Problem based on

a) How to handle compound variables in C
b) How to handle file in C
c) How to use command line argument in C

Textbook:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. Kanetkar Y.- Letus C, BPB Publication,15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

CO-PO Mapping:

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	-	-	2	-	-
CO3	3	3	3	3	-	-	-	3	3	-	-	-	3	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	2	-	-
CO5	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-

DETAILED CURRICULUM & SYLLABUS

2nd Year 1st Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	PH(ME) 301	Physics-II	3	0	0	3	3
2	PC	ME 301	Engineering Thermodynamics	3	0	0	3	3
3	PC	ME 302	Manufacturing Process	3	0	0	3	3
4	PC	ME303	Fluid Mechanics	3	0	0	3	3
5	ES	ME304	Engineering Mechanics	3	0	0	3	3
6	ES	ME 305	Data Structure	2	0	0	2	2
B. PRACTICAL								
7	BS	PH(ME)391	Physics-II lab	0	0	2	2	1.0
8	ES	ME 391	Machine Drawing	0	0	3	3	1.5
9	PC	ME392	Manufacturing Process Lab	0	0	3	3	1.5
10	PROJECT	PR391	Theme based Project III	0	0	1	1	0.5
11	PROJECT	PR392	Skill Development III: Technical Seminar Presentation	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES*								
12	MC	MC 381	Learning an Art Form [vocal or instrumental, dance, painting, clay modeling, etc.] OR Environmental Protection Initiatives		0	0	3	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**22**
D.MOOCS COURSES**								
13	MOOCS COURSES	HM301	MOOCS COURSE-I		3	1	4	4
TOTAL CREDIT WITH MOOCS COURSES								**26**

*After successful completion of MC381 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

COURSE NAME: PHYSICS-II
COURSE CODE: PH (ME) 301
CONTACTS: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3
Pre-Requisites: 1st year Basic Physics knowledge

Course Outcome:
After successful completion of this course learners will be able to
CO.1: explain electron transport in semiconductors using energy Band theory.
CO.2: apply Schrödinger equation in variety of atomic scale problems including nanomaterials.
CO.3: analyze the physics of various kinds of electric and magnetic materials
CO.4: justify the importance of Fermi energy level in turning electronic properties of various semiconductors

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	1	1	2	-	-	-	-	-	2
CO2	2	-	-	1	0	0	-	-	-	-	-	2
CO3	2	2	-	0	1	0	-	-	-	-	-	1
CO4	2	2	-	2	1	2	-	-	-	-	-	1
PH(ME) 301	2	2	-	2	1	2	-	-	-	-	-	1

Course Contents:

Module 1: Electric and Magnetic properties of materials (7L)

Module 1.01: Insulating materials:

Dielectric Material: Concept of Polarization, the relation between **D, E** and **P**, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), internal field, ferroelctric and piezoelectrics (Qualitative study). **3L**

Module 1.02: Magnetic materials and storage devices:

Magnetic Field & Magnetization M, relation between **B, H, M**. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of θ_p , Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) **4L**

Module 2: Ultrasound and infrasound (4L)

Ultrasound-Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-

destructive testing, cavitations, measurement of gauge), **Infrasound** – Introduction and definition, production, application: **4L**

Module 3: Quantum Mechanics-II (8L)

Formulation of quantum mechanics and Basic postulates; Operator Correspondence-Measurements in Quantum Mechanics- Eigen value, Eigen function, superposition principle, orthogonality of wave function, expectation value. Commutator. 4L

Time dependent Schrödinger's equation, formulation of time independent Schrödinger's equation by method of separation of variables, Schrödinger's equation as energy eigen value equation, Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only E<V0). 4L

Module 4: Statistical Mechanics (4L)

Concept of energy levels and energy states, phasespace, microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)- physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level. 4L

Module 5: Solid state physics (9L)

5.01: Introduction to Band theory (mention qualitatively improvement over free electron theory)-Kronig-Penny model (qualitative treatment)-Energy-band (E-k) diagram, formation of allowed and forbidden energy bands, Concept of effective mass – electrons and holes, crystal momentum. **4L**

5.01: Defects: Point defects; line defects; Dislocations, Types of dislocations, Planar defects, stacking faults, twins, grain boundaries, defect propagation (qualitative). **3L**

5.02: Vibration in solids: Lattice vibrations – Mono and diatomic lattice, concept of phonon, specific heat of solids-Dulong-Pettit law, Einstein, Debye theory (qualitative discussion). **2L**

Module 6: Physics of Nanomaterials (4L)

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, grapheme, electronic, environment, medical). **4L**

List of recommended Books:

1. Electromagnetics-B.B. Laud (TMH)
2. Electricity Magnetism-B.Ghosh (Book & Allied Publisher)
3. Electricity Magnetism-Chattopadhyay & Rakshit (New Central Book Agency)
4. Electricity Magnetism-Fewkes and Yardwood (Oxford University Press)

Module 2:

1. Advanced Quantum Mechanics-J. J. Sakurai (TMH)
2. Quantum Mechanics-Schiff (Addison-Wesley)
3. Quantum Computation and Quantum Information(10th Anniversary Edition)-Nielsen & Chuang (Cambridge University Press)
4. The physics of quantum information-Dirk Bouwmeester, Artur K. Ekert, Anton Zeilinger (Springer)
5. Quantum Mechanics-Cohen Tanuje.
6. Advanced Quantum Mechanics-P.A.M. Dirac

Module 3.

Statistical Mechanics by B.B. Laud
Statistical Mechanics by Singh and Singh
Statistical Mechanics by Satyaprakash

Module 4
1 Introduction to solid state physics-Kittel (TMH)
2. Solid State Physics- Ali Omar (Pearson Eduction)
3. Solid state physics- S. O. Pillai
4. Solid State Physics-A. J. Dekker (Prentice-Hall India)
5. Materials Science-Raghavan

Module 5
6. Nanotechnology-Rakesh Rathi (S. Chand Publishers)
7. Integrated Electronics-Millman Halkias (TMH)
8. Nanotechnology-Rakesh Rathi (S. Chand Publishers)
9. Nanoscience-H. E. Schaefer (Springer)

Genarl Book:
1. Engineering Physics by **Khan** and Panigrahi Publisher: Oxford.

COURSENAME: ENGINEERING THERMODYNAMICS
COURSE CODE:ME301
CONTACT: 3:0:0
TOTAL CONTACTHOURS: 36
CREDITS:3

Prerequisites: Physics(10+2level)

Course Outcomes: After successful completion of this course learners will be able to

CO1: Learn about the interrelationship of heat and work to draw an energy balance between a system and its surroundings.

CO2: Understand the second law limitation of energy conversion and differentiate realistic and unrealistic thermodynamic systems.

CO3: Carry out Entropy and Exergy analysis of thermal systems to evaluate sustainability of practical equipment in industries.

CO4: Evaluate the performance of energy conversion devices using utility thermodynamic cycles.

Course Contents:

Module	Syllabus	Contact Hrs
1	**Fundamentals** System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.	4
2	**Temperature & First Law of Thermodynamics** Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non- cyclic processes; Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.	4
3	**Pure Substance** Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two-phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	7
4	**First Law for Flow Processes** Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law	5

5	**Second law of Thermodynamics** Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale	**5**
6	**Entropy and its application** Clausius inequality; Definition of entropy S; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables- Principle of increase of entropy; Illustration of processes in TS coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles. Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.	**7**
7	**Thermodynamic cycles** Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.	**4**
	Total Contact Hours	**36L**

Text Books:

1. Yunus A. Cengel, Michael A. Boles, 2014, 8th Edition, Thermodynamics**:** An Engineering Approach, McGraw-Hill Education.
2. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

CO-PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	-	-	-	1	-	-	1	-	1	2	2	1
CO2	3	2	2	1	-	-	2	1	-	1	-	2	2	1	2
CO3	3	3	3	1	-	-	3	-	-	1	-	2	3	3	2
CO4	2	1	2	-	-	-	-	-	-	1	-	2	1	2	3

COURSENAME: MANUFACTURING PROCESSES
COURSECODE:ME302
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3

Prerequisite: No-prerequisite

Course Outcomes: After successful completion of this course learners will be able to

CO1: Understand the basics of manufacturing processes and concerned behavior of material properties.

CO2: Explain various casting processes for different molding designs and forming techniques for metal works.

CO3: Understand welding methods and analyze solid or liquid state joining

CO4: Analyze the principle of cutting tools and practice machining processes

Course Contents:

Module	Syllabus	Contact Hrs
1	**Metal Casting:** Casting and Molding: Major Classification, Casting Materials. Sand mould casting: Moulding sands: composition, properties & testing. Design of gating system: sprue, runner, ingate & riser, Estimation of powering time, Foundry equipments, Furnaces Melting, pouring and solidification Type of patterning, use of a core. Different type of sand mould casting: Floor mould casting, Centrifugal casting, Shell mould & CO2 casting, Investment casting. Permanent mould casting: Die casting, types, methods; advantages & applications. Slush casting, principle & use. Casting defects, types, causes & remedy; equipment; Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.	**10**
2	**Metal Forming:** Plastic deformation and yield criteria; Forging: Introduction, definition, classification, hot forging & cold forging, characteristics & applications. Forging material operations, equipments & tools: Smith forging, Drop forging, Pressing or press forging, Forging dies, materials & design. Rolling: Introduction, basic principles, hot rolling & cold rolling, characteristics & applications. Rolling processes & applications, operations, equipments & roll stands. Wire drawing & extrusion: Basic principles & requirements. Classification, methods & applications. Miscellaneous forming processes. load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending).	8

3 Joining Processes	Physics of welding, brazing and soldering; Different Welding Methods (SMAW, GMAW, GTAW, FCAW, solid state welding processes—pressure welding, friction welding, diffusion welding; resistance welding processes, Arc welding- different types of equipment, power sources, arc characteristics, electrode selection, precision welding processes like: PAW, LBW, EBW, USW, friction stir welding, under-water welding. Welding of plastics, ceramics and composites); Welding metallurgy, HAZ, effects of different process parameters on the characteristics of weldment. Welding fixtures, welding automation and robotic applications; Weldability of plain carbon steels, stainless steel, cast iron, aluminum and its alloys; Design considerations in welding, Solid and liquid state joining processes; Adhesive bonding; Welding defects-types, causes, inspection and remedial measures; testing of welded joints by visual inspection, dye-penetration (DP) test, ultrasonics and radiography. Safe Practices in Welding.	**10**
4– powder metallurgy	Principles of powder metallurgy; production of Metallic Powder; processing methods (mixing and blending, compacting, sintering, secondary operations etc.); Advantages; Designing for P/M; Metal injection Mounding (MIM); applications, advantages and limitations.	**5**
5- Press tool works	Press tool works: Basic principles, systems, operations & applications, Shearing, parting, blanking, piercing & notching, Cupping (drawing), Spinning & deep drawing Blanks & forces needed for shearing & drawing operations, Coining & embossing.	**3**
	Total Contact Hours	**36 L**

Text Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems.
3. Degarmo, Black & Kohser, Materials and Processes in Manufacturing

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	-	1	-	-	-	1	-	1	1	1
CO2	3	3	3	2	-	1	-	-	-	1	-	2	2	2
CO3	3	2	3	2	-	2	-	-	-	1	-	3	2	2
CO4	3	2	3	2	-	2	-	-	-	1	-	2	1	3

COURSE NAME: FLUID MECHANICS
COURSECODE:ME303
CONTACT: 3:0:0
TOTAL CONTACTHOURS: 36
CREDITS:3

Prerequisites: Physics and Mechanics (10+2 level)

Course Objectives: To introduce and explain fundamentals of Fluid Mechanics which is useful in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics, Heat Transfer, Power Plant etc.

Course Outcomes: After successful completion of this course learners will be able to
CO1: Get knowledge about fluid flow properties and analyze hydrostatic forces on flat or curved surfaces.
CO2: Explore the detailed analysis of kinematics and dynamics of fluid for laminar and turbulent flow and exploit the conservation equations for the flow regimes of practical interest.
CO3: Learn about boundary layer theory for a variety of constraints and understand the basics of a turbulent flow.
CO4: Explain the basics of compressible flow and apply for dimensional analysis for practical prototyping.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1- Introduction	Introduction to Fluid Mechanics - Fluid, Fluid types, Newton's law of viscosity, Fluid Properties	**2**
2- Analysis of Fluid Motion	Fluid statics: Forces on submerged surfaces; forces or vertical, horizontal, inclined and curved surfaces, Center of pressure. Stability of floating bodies. Fluid kinematics: fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines. Dynamics of fluid: equations of motion; Euler's equation; Navier-Stokes equation; Bernoulli's equation; Applications of Bernoulli's equation.	**9**
3- Viscous and Turbulent Flow	Flow through circular pipes, Flow between parallel plates, momentum and energy correction factors, Reynold's experiment, characteristics of turbulent flow, velocity distribution in turbulent flow through pipes in terms of average	**5**
4- Flow through pipes	Fluid friction in pipes, head loss due to friction. Darcy–Weisbach equation of friction loss; hydraulic grade line and total energy line. Variation of friction factor with wall roughness – Moody's chart. Minor losses in pipes.	**4**

4- Flow Measurement	Orifices, notches and weirs: Basic principle for flow through orifices, rectangular and V-notches, rectangular and trapezoidal weir.	**3**
5- Boundary layer flow	Definition; Boundary layer separation – basic concept. Drag force on a flat plate due to boundary layer, Turbulent layer on a flat plate, displacement thickness, momentum thickness	**4**
6- Submerged bodies	Flow of fluid and forces around submerged bodies; basic concepts of drag and lift.	**3**
7- Dimensional Analysis	Dimensions and dimensional homogeneity, Importance and use of dimensional analysis. Buckingham's π theorem with applications. Geometric, Kinematic and Dynamic similarity, Nondimensional Numbers, Model studies	**3**
8- Compressible Flow	Thermodynamic relations, Basic equations of compressible flow, velocity of pressure wave in a fluid, Mach number, Stagnation properties, area velocity relationship, flow of compressible fluid through orifices and nozzles fitted to a large	**3**

Text Books:

1. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications.
3. A textbook on Fluid Mechanics and Hydraulic Machines – Sukumar Pati, TMH
4. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.

Reference Books:

1. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
2. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.
3. Mechanics of Fluid – Bernard Massey, Taylor & Francis.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	1	1	-	-	-	-	-	1	-	-	3	2	1
CO2	3	3	2	2	-	-	-	-	-	1	-	1	2	3	1
CO3	3	2	1	2	-	-	-	-	-	1	-	1	3	2	1
CO4	2	2	1	1	-	-	-	-	-	1	-	1	1	3	1

COURSE NAME: ENGINEERING MECHANICS
COURSE CODE: ME304
CONTACTS: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Basic Concept of Physics

Course Outcomes: After successful completion of this course learners will be able to

CO1: To understand representation of force, moments for drawing free-body diagrams and analyze friction-based systems in static condition

CO2: To locate the centroid of an area and calculate the moment of inertia of a section.

CO3: Apply of conservation of momentum & energy principle for particle dynamics and rigid body kinetics

CO4: Understand and apply the concept of virtual work, rigid body dynamics and systems under vibration.

Course Content:

Module No.	Syllabus	Contact Hrs.
Module 1: Introduction to Engineering Mechanics:	Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Vector Mechanics- dot product, cross product, Problems	**8**
Module 2: Friction:	Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack, Problems.	**4**
Module 3: Basic Structural Analysis:	Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines, Problems.	**4**
Module 4: Centroid and Centre of Gravity:	Distributed Force: Centroid and Centre of Gravity; Centroids of a triangle, circular sector, quadrilateral, etc., Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications, Problems.	**4**
Module 5: Moment of Inertia:	Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook, Problems.	**4**
Module 6: Virtual Work and Energy	Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and	**3**

Method:	potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium, Problems.	
Module 7: Review of particle dynamics:	Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique), Problems	**5**
Module8: Introduction to Kinetics of Rigid Bodies:	Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation, Problems.	**4**

Text books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education

Reference books:

1. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics
2. Bansal R.K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications
3. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
4. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	-	-	-	-	1	1	-	1	-	1
CO2	3	3	2	2	-	-	-	-	1	1	-	2	1	-
CO3	3	2	3	2	1	-	-	-	1	1	-	2	1	-
CO4	3	3	3	3	-	-	-	-	1	1	1	1	2	1

COURSE NAME: DATA STRUCTURE
COURSE CODE: ME305
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisite: C language

Course outcomes: After successful completion of this course learners will be able to

CO1: For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
CO2: For a given Search problem (Linear Search and Binary Search) student will able to implement it.
CO3: For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
CO4: Students will able to write algorithms and practice programming in C++.

Course contents:

Module	Syllabus	Contact Hrs
I – Introduction	Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	**5**
II – Stacks and Queues	ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	**5**
III – Linked Lists and Trees	Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; **Trees:** Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	**8**
IV– Sorting and Hashing	Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.	**4**

V – C++	Object oriented Programming using C++	**2**
Total Contact Hours		**24**

Text Book:

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

Reference books:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	-	-	-	-	-	1	1	-	-	-
CO2	1	1	-	-	-	-	-	-	-	1	1	-	1	-
CO3	1	1	-	-	-	-	-	-	-	1	1	2	-	2
CO4	2	1	1	2	-	-	-	-	-	1	2	2	1	-

COURSE NAME: PHYSICS-II LAB
COURSE CODE: PH(ME) 391
CONTACTS: 0:0:3
CREDITS: 1.5

Course Outcome: After successful completion of this course learners will be able to
CO1: demonstrate experiments allied to their theoretical concepts
CO2: conduct experiments using semiconductors, dielectric and ferroelectrics, ultrasounds
CO3: classify various types of magnetic materials
CO4: participate as an individual, and as a member or leader in groups in laboratory sessions actively
CO5: analyze experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiments

***At least 7 experiments to be performed during the semester**

Experiments on Module 1: Electric and Magnetic properties of materials
1. Study of dipolar magnetic field behavior using deflection magnetometer.
2. Study of hysteresis curve of a ferromagnetic material using CRO.
3. Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
4. Measurement of Curie temperature of the given sample.
5. Determination of dielectric constant of given sample (frequency dependent)

Experiments on Module 2:Ultrasound (4L)
6. Determination of velocity of ultrasonic wave using piezoelectric crystal.

Module 3: Display, Optical Instruments &optoelectronic devices
7. Measurement of specific charge of electron using CRT.

Experiments on Module 4: Quantum Mechanics-II
8. Determination of Stefan's radiation constant.
9. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.
10. Determination of band gap of a semiconductor.
11. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor
12. Study of I-V characteristics of a LED.
13. Study of I-V characteristics of a LDR

In addition to regular 7 experiments it is **recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Probable experiments beyond the syllabus:
1. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.

2. Determination of thermal conductivity of a good conductor by Searle's mothod.
3. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	2	2		3	-	-	-	-	-	-	-		-	-	2
CO3	-	-	2	-	-	-	-	-	-	-	-	2	2	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-		2	-	-
CO5	-	-	-	-	-	-	-	-		2			-	-	2
PH(ME) 391	2	2	2	3					3	2		2	2		2

COURSE NAME: MACHINE DRAWING
COURSE CODE: ME391
CONTACT: 0:0:3
CREDITS: 1.5

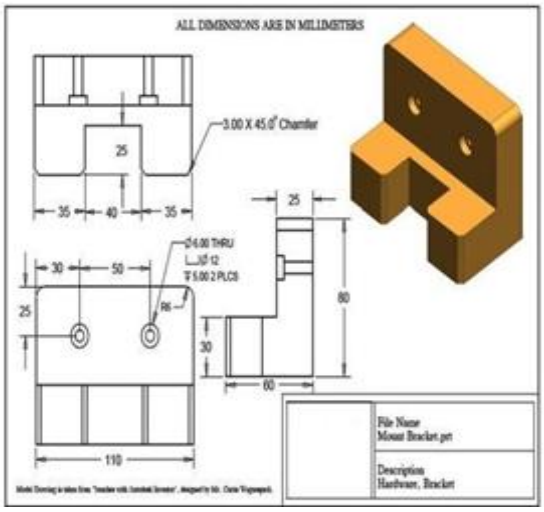
Prerequisite: Basic knowledge of Machine elements, engineering drawing/drafting

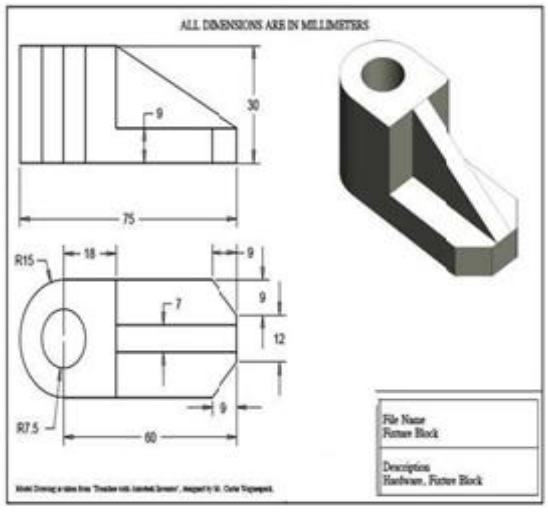
Course Objective: The objective of this lab is to practically demonstrate the failure criteria of different mechanical elements or bodies.

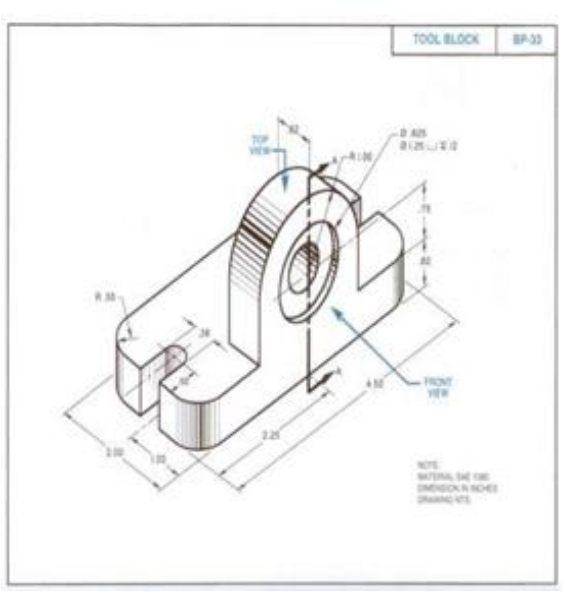
Course Outcomes: After successful completion of this course learners will be able to
CO1: Gain knowledge about the isometric views of a given three-dimensional object/part.
CO2: Understand and draw the orthogonal projection of a solid body and assemble drawing using part drawings.
CO3: Learn and practice 3D modeling of machine parts using AutoCAD / SOLIDWORKS / CATIA
CO4: Draft the shape and structure of different types of screws, keys and Couplings

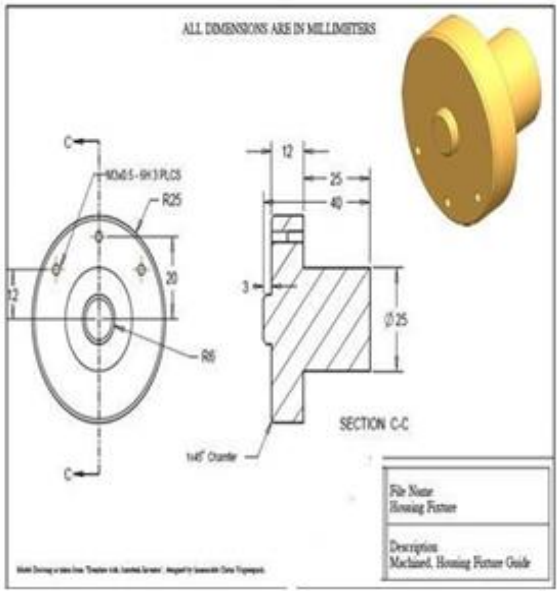
List of Drawing:

Sl.	Description
1	Schematic product symbols for standard components in welding and pipe joints
2	Orthographic projections of machine elements, different sectional views- full, auxiliary sections, Isometric projection of components (Manual and CAD)
3	Assembly and detailed drawings of a mechanical assembly (Manual Drafting) a) Plummer block b) Tool head of a shaping machine c) Tailstock of a lathe d) Welded pipe joints indicating work parts before welding
4	Basic 3D modeling practice of simple machine elements using AutoCAD or SolidWorks (At least 10, samples given)









Text Books:

1. Text Book on Engineering Drawing, Narayana/Kannaia H, Scitech
2. Mechanical Engineering Drawing and Design, S. Pal and M. Bhattacharyya
3. Machine Drawing by N.D. Bhatt
4. Machine Drawing by P.S. Gill
5. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International Pub.
6. Engineering Drawing with an Introduction to AutoCAD by D.A. Jolhe, Tata-McGraw-Hill Co.
7. Introduction to Solid Modeling Using SolidWorks 2008, Joseph C. Musto and William E. Howard
8. SOLIDWORKS 2016 Basic Tools, Paul Tran.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	1	1	2	-	1	2	2	-	2	2	-	1
CO2	1	2	3	1	1	2	-	1	2	2	-	2	2	2	-
CO3	2	3	3	2	2	2	-	1	2	2	-	3	2	-	1
CO4	2	2	3	1	2	2	-	1	2	2	-	2	2	1	1

COURSE NAME: MANUFACTURING PROCESS LAB
COURSE CODE: ME392
CONTACTS: 0: 0: 3
CREDITS: 1.5
Prerequisite: Manufacturing Process

Course Outcomes: After successful completion of this course learners will be able to
CO1: Fabricate basic parts and assemblies using machine shop equipment
CO2: Ascertain product and process quality levels through the use of precision measurement tools and statistical quality control charts.
CO3: Practice basic welding and forming techniques and modern improvements for sophisticated metal works.

List of Experiments:

Experiment No.	Description
1	To determine the percentage of clay content in dry sand
2	To determine the grain fineness number of dry and clay free sand.
3	To determine the moisture content quickly is fresh sand and mounding sand.
4	To determination the compressive strength, splitting strength and shearing strength of green sand by Pendulum Type Universal Strength Testing Machine
5	To determine the permeability number of Green sand, Core sand and Raw
6	Mould preparation and casting of metals after preparation of suitable molds.
7	Study of post casting operation like fettling, cleaning, deburring and polishing.
8	Practicing smithy or forging of carbon steels and testing for its property changes.
9	Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and Testing for Joint defects.
10	Machining practice in a Lathe, Shaping, Milling, Drilling machine.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	1	1	2	-	-	1	-	-	-	-	-	1	-	2
CO2	1	3	3	2	-	1	-	-	-	1	-	2	1	3
CO3	1	2	3	2	-	2	-	-	-	1	-	2	2	3

Detailed Curriculum & Syllabus

2nd Year 2nd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	HSMC	HSMC402	Gender Culture and Development	3	0	0	3	3
2	BS	M401	Mathematics III	3	0	0	3	3
3	ES	ME401	Materials Engineering	3	0	0	3	3
4	PC	ME402	Fluid Machinery	3	0	0	3	3
5	PC	ME403	Strength of Material	3	0	0	3	3
6	PC	ME404	Applied Thermodynamics	3	0	0	3	3
B. PRACTICAL								
7	ES	M(ME)491	Numerical Methods Lab	0	0	2	2	1
8	PC	ME491	Material Testing Lab	0	0	3	3	1.5
9	PC	ME492	Fluid Mechanics & Fluid Machines Lab	0	0	3	3	1.5
10	PROJECT	PR491	Theme based Project IV	0	0	1	1	0.5
11	PROJECT	PR492	Skill Development IV: Soft Skill & Aptitude-I	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC401	Environmental Science	0	0	3	3	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23**
D. MOOCS COURSES*								
13	MOOCS COURSES	HM401	MOOCS COURSE-II	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27**

*After successful completion of MC401 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

COURSE NAME: GENDER, CULTURE AND DEVELOPMENT
COURSE CODE: HSMC402
CONTACTS: 2L:0T:0P
TOTAL CONTACT HOURS: 24
CREDIT: 2
Prerequisite: None

Course Outcomes: On successful completion of the learning sessions of the course, the learner will be able to:
CO1: Provide an analysis of the location of women in the processes of economic development; to understand what economic development is, the scales or levels at which it occurs, and the centrality of gender at every level.
CO2: Examine theoretical and conceptual frameworks for that analysis.
CO3: Reflect upon linkages between the global economy and the gendered macro and micro process of development and transitions from 'government' to 'governance.'
CO4: Explain the usefulness of a rights-based approach to gender justice.
CO5: Provide basis for research, practical action and policy formulation and or evaluating for evaluating directions and strategies for social change from a gender perspective.

Course Content

Module No.	Syllabus	Contact Hrs.
1	Introduction to Gender, Definition of Gender, Basic Gender Concepts and Terminology, Exploring Attitudes towards Gender, Social Construction of Gender	**4**
2	Gender Roles and Relations, Types of Gender Roles, Gender Roles and Relationships Matrix, Gender-based Division and Valuation of Labour	**6**
3	Gender Development Issues, Identifying Gender Issues, Gender Sensitive Language, Gender, Governance and Sustainable Development, Gender and Human Rights, Gender and Mainstreaming.	**5**
4	Gender-based Violence, The concept of violence, Types of Gender-based violence, The relationship between gender, development and violence, Gender-based violence from a human rights perspective.	**5**
5	Gender and Culture Gender and Film, Gender and Electronic Media, Gender and Advertisement, Gender and Popular Literature.	**4**

Text Books:

1. Beneria, Lourdes. (2004). Gender, Development, and Globalization: Economics as if All People Mattered. Roultedge Press. (GDGE)
2. Molyneux and Razavi. (2002). Gender Justice, Development and Rights. Oxford University Press (GJDR or WGD)
3. Visvanathan, Duggan,Wiegersma and Nisonoff. (2011). The Women, Gender and Development Reader. 2nd Edition. Zed Press (WGD)

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	2	1	-	-	-	2	3	3	1	-	2
CO2	3	2	-	1	3	2	-	1	2	-	3	3	2	-	1
CO3	3	2	2	-	2	3	1	-	2	1	3	3	3	1	-
CO4	3	1	-	2	-	-	-	2	-	3	3	3	2	-	2
CO5	3	2	-	1	-	1	2	-	2	-	3	3	3	1	-

COURSE NAME: MATHEMATICS- III
COURSE CODE: M401
TOTAL CONTACT HOURS: 36
CREDIT: 3
Prerequisite:
The students to whom this course will be offered must have the concept of (10+2) standard calculus, basic probability and differential equations.

Course Objectives:
The objective of this course is to disseminate the prospective engineers with basic techniques for solving partial differential equations. It also aims to equip the students with concepts and tools of calculus of complex variables, Fourier series and Fourier transform, and probability distribution as an intermediate to the advanced level of applications that they would find useful in their disciplines.

Course Outcomes (COs):
On successful completion of the learning sessions of the course, the learner will be able to:

CODES	BLOOM'S TAXONOMY	DESCRIPTIONS
CO1	Remembering	Recall the underlying principle and properties of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, and partial differential equation.
CO2	Understanding	Exemplify the variables, functions, probability distribution and differential equations and find their distinctive measures using the underlying concept of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, and partial differential equation.
CO3	Applying	Apply Cauchy's integral theorem and the residue theorem to find the value of complex integration, and compute the probability of real-world uncertain phenomena by identifying probability distribution that fits the phenomena.
CO4	Applying	Solve partial differential equation using method of separation of variables
CO5	Analyzing	Find the Fourier series and Fourier transform of functions by organizing understandings of underlying principles and also evaluate the integral using Parseval's identity.

Course Content:
MODULE I: ***Fourier series and Fourier Transform: (9 Lectures)***
Fourier series: Dirichlet's Conditions; Euler's Formula for Fourier Series; Fourier Series for functions of period 2π; Sum of Fourier series (examples); Theorem for the convergence of Fourier series (statement only); Fourier series of a function with its periodic extension; Half range Fourier series: Construction of half range Sine series and half range Cosine Series; Parseval's identity (statement only) and related problems.

Fourier Transform: Fourier Transform, Fourier Cosine Transforms, Fourier Sine Transforms (problems only); Properties of Fourier Transform: Linearity, Shifting, Change of Scale, Modulation (problems only); Fourier Transform of Derivatives (problems only); Convolution Theorem (statement only), Inverse of Fourier Transform (problems only).

MODULE II: ***Probability Distributions: (9 Lectures)***
Random Variable: Discrete and Continuous (definition & examples); Probability Distribution (definition & examples); Probability Mass Function, Probability Density Function and Distribution Function for a single random variable only (definition, properties & related problems); Expectation, Variance and Standard Deviation for a single random variable only (definition, properties & related problems); Binomial Distribution, Poisson Distribution, Binomial Approximation to Poisson Distribution and Normal Distribution (problems only), Mean, Variance and Standard Deviation of Binomial, Poisson and Normal Distribution (problems only).

MODULE III: ***Calculus of Complex Variable: (13 Lectures)***
Functions of a Complex Variable (definition and examples); Concept of Limit, Continuity and Differentiability (problems only); Analytic Functions (definition and examples); Cauchy-Riemann Equations (statement only& related problems); Sufficient condition for a function to be analytic (statement only & related problems).
Concept of Simple Curve, Closed Curve, Smooth Curve & Contour; Some elementary properties of complex integrals (problems only); Cauchy's Theorem (statement only & related problems); Cauchy's Integral Formula(statement only & related problems); Cauchy's Integral Formula for the derivative of an analytic function(statement only & related problems); Cauchy's Integral Formula for the successive derivatives of an analytic function (statement only & related problems); Taylor's series and Laurent's series (problems only).
Zero of an Analytic Function and its order (definition & related problems); Singularities of an Analytic Function: Isolated Singularity and Non-isolated Singularity (definition & related problems); Essential Singularities, Poles (Simple Pole and Pole of Order m) and Removable Singularities (definition & related problems); Determination of singularities and their nature (problems only); Residue (definition & examples); Determination of the residue of a given function; Cauchy's Residue theorem (statement only & related problems). Application of Residue.

MODULE IV: ***Partial Differential Equation (PDE): (5 Lectures)***
Solution of PDE: Method of Separation of Variables.
Solution of Initial Value & Boundary Value Problem: One Dimensional Wave Equation, One Dimensional Heat Equation, Two-Dimensional Laplace Equation.

Project Domains:
1. Study of physical processes through PDE.
2. Application of calculus of complex variable in real world engineering problems.
3. Study of uncertainty in real world phenomena using probability distribution.
4. Application of Fourier series and Fourier transform in engineering problems.

Text Books:
1. Herman, R. L. *An Introduction to Fourier Analysis*, Chapman and Hall/CRC, 2016.
2. Grafakos, L. *Classical Fourier Analysis*, Springer, India, Private Ltd.

3. Das, N.G. *Probability and Statistics*; The McGraw Hill Companies.
4. Gupta, S. C. and Kapoor, V. K. *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons.
5. Mathews, J. H. and Howell, R. W. *Complex Analysis for Mathematics & Engineering*, Jones & Bartlett Pub, 2006.
6. Chowdhury, B. *Elements of Complex Analysis*, New Age International, 1993.
7. Raisinghania, M .D. *Advanced Ordinary & Partial Differential. Equation*; S. Chand Publication.
8. Ross, S. L. *Differential Equations*, John Willey & Sons.
9. Grewal, B. S. *Higher Engineering Mathematics*, Khanna Pub.
10. Kreyszig, E. *Advanced Engineering Mathematics*, John Wiley & Sons, 2006.

Reference Books:

1. Gray, R. M. and Goodman, J. *Fourier Transforms: An Introduction for Engineers*, Springer, US, 1995.
2. Lipschutz & Lipson, *Schaum's Outline in Probability (2ndEd)*, McGraw Hill Education.
3. Spiegel, M. R. *Theory and Problems of Probability and Statistics (Schaum's Outline Series)*, McGraw Hill Book Co.
4. Goon, A.M., Gupta M .K. and Dasgupta, B. *Fundamental of Statistics*, The World Press Pvt. Ltd.
5. Soong, T. T. *Fundamentals of Probability and Statistics for Engineers*, John Wiley & Sons Inc, 2004.
6. Delampady, M. *Probability & Statistics*, Universities Press.
7. Spiegel, M. R. *Theory and Problems of Complex Variables (Schaum's Outline Series)*, McGraw Hill Book Co.
8. Sneddon, I. N. *Elements of Partial Differential Equations*, McGraw Hill Book Co.

CO-PO Mapping:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	-	-	-	-	-	-	-	-	1	1	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1	3	1	-
CO4	3	2	2	-	-	-	-	-	-	-	-	1	2	-	2
CO5	3	3	2	3	-	-	-	-	-	-	-	1	3	1	-

COURSE NAME: MATERIALS ENGINEERING
COURSECODE:ME401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS:3

Prerequisite: Engineering Physics and Engineering Chemistry.

Course Outcomes: After successful completion of this course learners will be able to
CO1: Identify crystal structures for various materials and understand the defects in such structures
CO2: Analyze the effect of heat treatment of mechanical properties of a material
CO3: Understand how to tailor material properties of ferrous and non-ferrous alloys
CO4: Learn about advanced materials useful in modern industrial application.

Course Contents:

Module	Syllabus	Contact Hrs
1 – Crystal Structure	Unit cells, Metallic crystal structures, Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.	**6**
2 – Mechanical Property measurement	Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell, Vickers and their relation to strength.	**7**
3 – Metals & Alloys	Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; Iron - Iron-carbide phase diagram, and microstructure analysis of ferrous materials, cast iron, steel.	**6**
4 – Heat treatment	Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening	**7**
5 – Alloying of steel	Properties of stainless steel and tool steels, maraging steels- cast irons; - copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al -Cu – Mg alloys- Nickel based superalloys and Titanium alloys	**5**
6- Ceramics and Advanced Materials	Structure, properties and application of ceramics, Composite Types, Types and properties of main composition, Smart Materials, Ferroelastic and Piezoelectric materials, Nanomaterials, Biomaterials, Shape memory alloys	**5**

	Total Contact Hours	**36 L**

Text Books:

1. W. D. Callister,2006, MaterialsScienceandEngineering-AnIntroduction,6th Edition, Wiley India.
2. V. Raghavan, Material Science and Engineering, Prentice Hall of India Private Limited, 1999.
3. U. C. Jindal, Engineering Materials and Metallurgy, Pearson,2011.

Reference Books:

1. Kenneth G. Budinski and Michael K. Budinski, Engineering Materials, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	2	2	-	-	-	-	-	1	-	1	2	3	2
CO2	1	2	3	2	-	1	-	-	-	1	-	2	1	3	2
CO3	1	3	3	2	-	2	1	-	-	1	-	2	2	2	2
CO4	1	1	3	2	1	2	2	-	-	1	-	2	2	2	2

Course Name: Fluid Machinery
Course Code: ME402
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3
Prerequisite: Fluid Mechanics

Course Outcomes: After successful completion of this course learners will be able to
CO1. Discuss the characteristics of centrifugal pump and reciprocating pumps
CO2. Calculate forces and work done by a jet on fixed or moving plate and curved plates
CO3. Analyze the working of turbines and select the type of turbine for an application.
CO4. Evaluate hydraulic machines and select the suitable one for a specific application

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	**Impact of Jets and Jet Propulsions:** Euler's fundamental equation, Force exerted by a liquid jet on a stationary flat plate, force exerted by a liquid jet on a stationary curved vane, force exerted by a liquid jet on a hinged plate, force exerted by a liquid jet on moving flat plates, force exerted by a liquid jet on moving curved vane, jet propulsion.	4
2.	**Hydraulic Turbines:** Essential element of a hydroelectric power plant; head and efficiencies of hydraulic turbines; classifications of hydraulic turbines, Pelton turbine, reaction turbine, Francis turbine, Kaplan turbine; draft tube; cavitation in hydraulic machines; dimensional analysis and similarity laws for rotodynamic machines; specific speed of hydraulic turbines; unit quantities of hydraulic turbines; characteristic curves of hydraulic turbines; governing of pelton wheel and turbines.	8
3.	**Centrifugal Pump:** Components of a centrifugal pump, working principle, work done by impeller, different heads in a pumping system, different efficiencies, characteristics, minimum speed for starting a centrifugal pump, multistage centrifugal pumps, specific speed, model testing, cavitation & seperation, net positive suction head.	8
4.	**Positive Displacement Pump:** Components of a reciprocating pump, working principle, types of reciprocating pumps, discharge and power requirement, slip and coefficient of discharge, variation of velocity and acceleration in the suction and delivery pipes due to acceleration of the piston, frictional head on suction and delivery pipes, indicator diagram, air vessels. Comparison of centrifugal and reciprocating pumps, Performance characteristics.	8

5.	**Miscellaneous Hydraulic Machines:** Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic ram, hydraulic lift, hydraulic crane, hydraulic coupling, hydraulic torque converter, hydraulic actuators, hydraulic valves, air lift pump, jet pump.	8
Total Contact Hours		**36 L**

Text Books:

1. A textbook on Fluid Mechanics and Hydraulic Machines – Sukumar Pati, TMH
2. Fluid Mechanics & Machinery – R. K. Bansal, Luxmi Publications.
3. Introduction to Fluid Mechanics & Fluid Machines – Som Biswas, Chakraborty, TMH.
4. Fluid Mechanic s & Turbo Machines – M.M. Das, PHI, 2010.
5. Fluid Mechanics and Fluid Power Engineering by D S Kumar, S K Kataria & Sons

Reference Books:

1. Fluid Mechanics & Machinery – C. Ratnam, A.V. Kothapalli, I.K. International Publishing House Ltd, 2010.
2. Fluid Mechanics & Machinery – C.S.P Ojha, R. Berndtsson, P.N. Chandramouli, OUP.
3. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
4. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	1	-	-	-	-	-	1	3	-	2	3	2
CO2	3	3	2	2	-	3	-	-	-	1	1	2	2	2	3
CO3	2	2	2	2	-	1	-	-	-	1	2	-	2	3	3
CO4	2	3	2	-	1	1	3	-	-	1	1	3	2	2	2

COURSE NAME: STRENGTH OF MATERIALS
COURSE CODE: ME 403
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: Engineering Mechanics

Course Outcomes: After successful completion of this course learners will be able to
CO1: Recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
CO2: Evaluate the strains and deformation in materials that will result due to the elastic stresses developed within the materials for simple types of loading.
CO3: Quantify mechanical integrity and failure in materials
CO4: Analyze application of materials with respect to their strength and weakness.

Course Contents:

Module	Syllabus	Contact Hrs
1 - Deformation in solids	Hooke's law, stress and strain- tension, compression and shear stresses, elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.	**7**
2 – Failure Theorie	Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb Theory	**4**
3 – Beams	Beams and types of transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.	**7**
4 – Moment of inertia	Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.	**6**
5 – Torsion	Torsional stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.	**6**
6 – Pressur e	Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure	**6**
Total Hours (36 lectures)		

Text Books:
1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata

Mc Graw Hill Publishing Co. Ltd., New Delhi 2005.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	-	-	-	-	-	1	-	1	2	-	-
CO2	3	2	2	1	-	-	-	-	-	1	-	2	-	2	3
CO3	1	3	3	1	-	2	2	-	-	1	-	2	2	-	-
CO4	1	1	3	2	-	1	2	-	-	1	-	2	2	2	2

COURSE NAME: APPLIED THERMODYNAMICS
COURSECODE:ME404
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3
Prerequisite: Engineering Thermodynamics

Course Outcomes: After successful completion of this course learners will be able to
CO1: Get a good understanding of various practical vapor-based power cycles and heat pump cycles.
CO2: Apply energy conversion principles in various gas-based power cycles and evaluate their efficiencies.
CO3: Analyze phenomena occurring in high-speed compressible flows through nozzles and study the functioning & application of compressors.
CO4: Analyze energy conversion in various thermal devices such as combustors and air coolers.

Course Contents:

Module	Syllabus	Contact Hrs
1 Fuels and Combustion Analysis	Introduction to solid, liquid and gaseous fuels – Stoichiometry, exhaust gas analysis - First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and composition calculations using free energy	**6**
2 Vapor Based Cycles	Vapor power cycles, Rankine cycle with superheat, reheat and regeneration, exergy analysis. Supercritical and ultra-supercritical Rankine cycle - Vapor compression refrigeration cycles, refrigerants and their properties	**8**
3 Gas Based Cycles	Gas power cycles, Air standard Otto, Diesel and Dual cycles - Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles	**8**
4 Psychrometry	Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.	**4**
5 Reciprocating Compressors	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.	**5**
6 Nozzle and Diffuser	Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- Flow of steam and refrigerant through nozzle, supersaturation, compressible flow in diffusers, efficiency of nozzle and diffuser	**5**
Total Contact Hours		**36**

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G.J., 2003,6thEdition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Nag, P. K,1995, Engineering Thermodynamics, Tata McGraw-HillPublishing Co. Ltd

Reference Books

1. Jones, J. B. and Duggan,R. E., 1996,EngineeringThermodynamics,Prentice-HallofIndia
2. Moran, M. J.and Shapiro, H. N.,1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	-	1	1	1	-	1	1	1	3	3	2
CO2	2	2	2	3	-	1	2	1	-	1	1	1	2	3	3
CO3	3	3	2	3	-	2	2	-	-	1	1	1	2	2	2
CO4	2	3	2	2	-	2	2	-	-	1	2	1	2	2	2

SUBJECT NAME: NUMERICAL METHODS LAB
CODE: M(ME)491
CREDIT: 1.5
TOTAL CONTACT HOUR: 30

Prerequisite: Any introductory course on programming language (example. C/ Matlab).

Course Outcomes (COs):
On successful completion of the learning sessions of the course, the learner will be able to:

CODES	BLOOM'S TAXONOMY	DESCRIPTIONS
CO1	Understand	Understand the theoretical workings of numerical techniques with the help of C/Matlab
CO2	Apply	Execute basic command and scripts in a mathematical programming language
CO3	Apply	Apply the programming skills to solve the problems using multiple numerical approaches.
CO4	Analyze	Analyze if the results are reasonable, and then interpret and clearly communicate the results.

Course Content:

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination, Tridiagonal matrix algorithm, Gauss-Seidel iterations. LU Factorization method.
4. Assignments on numerical solution of Algebraic Equation by Bisection method, Regula-Falsi method, Secant Method, Newton-Raphson method
5. Assignments on ordinary differential equation: Euler's method, Euler's modified method, Runge-Kutta methods, Taylor series method and Predictor-Corrector method.

Implementation of numerical methods on computer through C/C++ and commercial Software Packages: Matlab / Scilab / Labview / Mathematica/NAG (Numerical Algorithms Group)/Python.

CO-PO Mapping:

PO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	2	3	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	2	-
CO4	3	3	2	3	-	-	-	-	-	-	-	1	2	-	-

COURSE NAME: MATERIALS TESTING LABORATORY
COURSE CODE: ME491
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Engineering Mechanics and Engineering Materials.

Course Objective:
To measure the mechanical properties of a material to understand the deformation behavior of materials and observe the microstructure of a material sample under heat treatment.

Course Outcomes:
1. Acquire experimentation skills in the field of material testing.
2. Apply the knowledge to analyse a material failure and determine the failure inducing agent/s.
3. Apply the knowledge of testing methods in related areas.
4. Understand how to improve structure/behavior of materials for various industrial applications.

List of experiments:
At least 6 experiments need to be conducted.
1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinell and Rockwell hardness tests on metallic specimen
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge
7. Microscopic examination of heat-treated and untreated metallic samples
8. Demonstration of Fatigue Test
9. Strut test (Column buckling experiment)
10. Determination of moment of inertia of rotating bodies

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	2	1	2	-	1	3	2	2
CO2	2	2	-	-	-	-	-	2	2	2	-	2	2	2	2
CO3	2	3	-	-	-	2	1	2	2	2	-	2	2	2	2
CO4	3	3	-	-	-	2	1	2	2	2	-	2	2	2	2

COURSE NAME: FLUID MECHANICS & FLUID MACHINES LAB
COURSE CODE: ME492
CONTACT: 0: 0: 3
CREDITS: 1.5

Prerequisite: Fluid Mechanics and Fluid Machines

Course Outcomes: After successful completion of this course learners will be able to
CO1: Recall the coefficient of discharge for several flow measuring devices to explore the reasons of differences in theoretical calculation and practical measurements.
CO2: Demonstrate hydraulic turbine and carry out their performance**.**
CO3: Examine and understand pump working characteristics under given constraints.
CO4: Estimate frictional forces applicable in a flow channel to determine major and minor losses.

List of Experiments:
1. Measurement of Coefficient of Discharge of an Orifice
2. Measurement of Coefficient of Discharge of a Venturimeter
3. To verify the Bernoulli's Theorem
4. To find the critical Reynolds number for pipe flow
5. To determine friction factor for a flow through pipe
6. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
7. Determination of the performance characteristics of a centrifugal pump
8. Determination of the performance characteristics of a Pelton Wheel
9. Determination of the performance characteristics of a Francis Turbine.
10. Determination of the performance characteristics of a Kaplan Turbine

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	2	-	1	-	-	2	1	-	2	2	2	1
CO2	2	-	3	2	-	-	1	-	2	1	1	2	1	2	1
CO3	2	-	2	2	-	1	-	-	2	1	1	2	1	2	1
CO4	2	-	2	2	-	-	-	-	2	1	1	2	1	2	1

COURSE NAME: ENVIRONMENTAL SCIENCE
COURSE CODE:MC401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
Prerequisite: Basic Chemistry

Course Outcomes After successful completion of this course learners will be able to
CO1: Able to understand the natural environment and its relationships with human activities.
CO2: To apply the fundamental knowledge of science and engineering to assess environmental and health risk.
CO3: To develop guidelines and procedures for health and safety issues obeying the environmental laws and regulations.
CO4: Acquire skills for scientific problem-solving related to air, water, noise & land pollution.

Course Content:

1. General **11 L**

1.1 Natural Resources: Forest Resource, water resource, mineral resource, energy resources: alternative source of energy
1.2Population Growth: Exponential Growth, logistic growth, Maximum sustainable yield, demography
1.3Disaster Management: Types of disasters (Natural & Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect & control)
1.4Ecology & Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain & Food web, Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems
1.5 Environmental Management: Environmental impact assessment, Environmental laws and protection act of India(The Environment protection Act, Air pollution Act, Water Act, Wildlife Protection Act) , Hazardous waste(management and Handling) Rules.

2. Air pollution and control **10L**

2.1Sources of Pollutants: point sources, nonpoint sources and manmade sources primary & secondary pollutant
2.2 Types of air pollutants: primary & secondary pollutant ; Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog (Photochemical smog and London smog),
2.3Effects on human health & climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion
2.4 Air pollution and meteorology: Ambient Lapse Rate, Adiabatic Lapse Rate, Atmospheric stability & Temperature inversion
2.5 control of air pollution (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury),

3. Water Pollution **9L**

3.1 Classification of water (Ground & surface water)
3.2 Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients,

Salts, heavy metals, pesticides, volatile organic compounds.
3.3 Surface water quality parameters: pH, DO, 5 day BOD test, BOD reaction rate constants, COD. Numerical related to BOD
Lake: Eutrophication [Definition, source and effect].
3.4Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only),ground water pollution (Arsenic & Fluoride; sources, effects, control)
3.5 Quality of Boiler fed water: DO, hardness, alkalinity, TDS and Chloride
3.7 Layout of waste water treatment plant (scheme only).

4. Land Pollution **3L**
4.1 Types of Solid Waste: Municipal, industrial, commercial, agricultural, domestic, hazardous solid wastes (bio-medical), E-waste
4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages).
4.3 Waste management: waste classification, waste segregation, treatment & disposal

5. Noise Pollution **3L**
5.1 Definition of noise, effect of noise pollution on human health,
5.2 Average Noise level of some common noise sources
5.3 Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, $L10$ (18 hr Index).
5.4 Noise pollution control.

Text Books:
1. A Textbook of Environmental Studies, Shashi Chawla. Tata McGraw Hill Education Private Limited
2. Environmental Studies, Dr. J P Sharma, University Science Press
3. Environmental Engineering, J K Das Mohapatra, Vikas Publication

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	-	-	2	3	3	-	-	1	2	1	-	-
CO2	3	3	3	1	1	2	3	3	-	-	1	2	1	-	-
CO3	3	3	3	2	1	2	3	3	-	-	1	2	1	-	-
CO4	1	1	1	1	2	2	3	3	-	-	1	2	1	-	-

Detailed curriculum & Syllabus

3rd Year 1st Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	HSMC	HSMC 503	Universal Human Values 2: Understanding Harmony	2	0	0	2	2
2	PC	ME501	Heat Transfer	3	0	0	3	3
3	PC	ME502	Manufacturing Technology	3	0	0	3	3
4	PC	ME503	IC Engine & Hybrid Vehicles	3	0	0	3	3
5	PC	ME504	Kinematics & Dynamics of Machines	3	0	0	3	3
6	PE	ME505	Professional Elective-I A. Refrigeration and Air Conditioning B. Composite Materials C. Finite Element Analysis	3	0	0	3	3
B. PRACTICAL								
7	PC	ME591	Heat Transfer Lab	0	0	3	3	1.5
8	PC	ME592	Manufacturing Technology Lab	0	0	3	3	1.5
9	PC	ME593	Thermal Engineering Lab	0	0	3	3	1.5
10	PE	ME594	Professional Elective-I Lab D. Refrigeration and Air Conditioning Lab E. Composite Materials Lab F. Finite Element Analysis Lab	0	0	3	3	1.5
11	PROJECT	PR591	Minor Project I	0	0	3	3	1
12	PROJECT	PR592	Skill Development V: Soft Skill & Aptitude-II	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC501	Intellectual Property Right	2	0	0	0	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**24.5**
D. MOOCS COURSES**								
14	MOOCS COURSES	HM501	MOOCS COURSE-III	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**28.5**

*After successful completion of MC501 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET

COURSE NAME: UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY
COURSE CODE: HSMC503
CONTACTS: 3L:0T:0P
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite*:* None

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Develop holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
CO2: Cultivate the harmony in the human being, family, society and nature/existenc.
CO3: Strengthen self-reflection.
CO4: Build commitment and courage to act.

Course Content

Module No.	**Syllabus**	**Contact Hrs.**
Module 1:	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education: Self-Exploration–what is it? Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment ofaspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.	8
Module 2	Understanding Harmony in the Human Being - Harmony in Myself! Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Ensuring health vs dealing with disease discussion.	6
Module 3:	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship: Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships)	7

	and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Elicit examples from students' lives.	
Module 4:	Understanding Harmony in the Nature and Existence - Whole existence as Coexistence: Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of echnology etc.	8
Module 5	Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations. Practice Exercises and Case Studies in Practice (tutorial) Sessions to discuss the conduct as an engineer or scientist etc.	7

Text Books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	2	1	-	-	-	2	3	3	1	-	2
CO2	3	2	-	1	3	2	-	1	2	-	3	3	2	-	1
CO3	3	2	2	-	2	3	1	-	2	1	3	3	3	1	-
CO4	3	1	-	2	-	-	-	2	-	3	3	3	2	-	2

COURSE NAME: HEAT TRANSFER
COURSE CODE: ME501
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3
Prerequisite: Thermodynamics, Fluid mechanics,

Course Outcomes: After successful completion of this course learners will be able to

CO1: Understand the basic laws & constraints of heat transfer to analyze problems involving steady state or transient heat conduction in simple geometries.
CO2: Survey the analytical solutions of free and forced convection problems to apply in modern research sectors of heat and mass transfer.
CO3: Evaluate the radiation heat transfer between black body and gray body surfaces and obtain numerical solutions of combined mode heat transfer problems in practice.
CO4: Analyze the effectiveness of several type of heat exchanger and develop skills for industrial design solutions regarding boiling and condensation.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Conduction	Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer- approximate solution to unsteady conduction heat transfer by the use of Heissler charts	**10**
2 Convection	Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	**9**
3 Radiation	Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method	**7**

4 Heat Exchangers	Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods.	**5**
5 Boiling & Condensation	Boiling and Condensation heat transfer, Pool boiling curve	**3**
6 Mass Transfer	Introduction to mass transfer, Similarity between heat and mass transfer	**2**
Total Hours		**(36 L)**

Text Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J. P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F. P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. P.K. Nag, Heat & Mass Transfer, TMH.
5. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002

Reference Books:

6. S.K. Som, Introduction to Heat Transfer, PHI.
7. Kreith, Principles of Heat Transfer, Cengage learning.
8. O.P. Single, Heat & Mass Transfer, Macmillan India.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	3	-	1	1	-	-	-	2	1	3	2	-
CO2	3	3	2	3	-	1	1	-	-	-	1	2	3	2	-
CO3	2	2	1	2	-	1	1	-	-	-	1	1	3	2	-
CO4	3	2	2	3	-	2	2	-	-	-	2	2	3	2	2

COURSE NAME: MANUFACTURING TECHNOLOGY
COURSE CODE: ME502
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Manufacturing Processes, Materials Engineering.

Course Outcomes: After successful completion of this course, the learner will be able to:
CO1: Understand the cutting tool geometry, mechanism and mechanics of machining, cutting temperature and application of cutting fluids, tool life and tool materials.
CO2: Understand the basic operations and kinematic structure of machine tools needed for manufacturing.
CO3: Judge the surface texture, flatness, roughness, dimensions, etc. of a given specimen and products with the help of knowledge of metrology for checking the quality of manufactured products.
CO4: Explore and use the knowledge of the assembly of different components in practical projects.

Course Contents:

Module	Syllabus	Contact Hrs
1 Machining Principles	Machining: Basic principle, definition and requirements. Cutting Tools: Geometry of single point and multi point tools in ASA, ORS and NRS systems, Conversion of tool angles. Mechanism and Mechanics of machining: Chip formation in various cutting and determination of various force components. Cutting temperature and cutting fluids. Tool Life: Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials.	**12**
2 Machine Tools	Introduction, Purpose of use, definition and general features of machine tools. Generatrix and Directrix and tool–work motions in different operations of conventional machine tools. Major components and their functions in machine tools. Kinematic structure of conventional and non-conventional machine tools.	**8**
3 Metrology	Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferrometry; Metrology in tool wear and part quality including surface integrity; Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality.	**10**
4 Assembly Practices	Manufacturing and assembly, alignment and testing methods, tolerance analysis, process planning, selective assembly, Material handling and devices.	**6**
Total Hours (36 L)		

Text Books:

4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley India (P) Ltd., New Delhi.
5. G. Kuppuswamy, Principles of Metal Cutting, University Press, Hyderabad.
6. Stephenson &Agapion, Metal Cutting Theory and Practice, Taylor and Francis, NY.
7. G.C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Central Book Agency (P) Ltd., Kolkata.
8. R.K. Jain, Metrology, Khanna Publication, New Delhi.
9. N.V. Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford, New Delhi.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	2	3	1	2	-	1	1	-	1	3	2	1
CO2	3	1	1	2	2	1	1	-	1	1	-	1	2	2	1
CO3	3	3	2	2	3	-	1	-	1	1	-	1	3	2	1
CO4	3	2	-	-	1	-	-	-	3	1	2	1	3	2	1

COURSENAME: INTERNAL COMBUSTION ENGINE AND HYBRID VEHICLES
COURSE CODE: ME503
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3

Prerequisite: Applied Thermodynamics, Fluid mechanics

Course Outcomes: After successful completion of this course learners will be able to

CO1: Get the knowledge of engine nomenclature, performance parameters and characteristics of different fuels to differentiate several types of I C engine designs.
CO2: Understand several losses in an engine Understand several losses in an engine to predict performance and fuel economy trends with good accuracy,
CO3: Identify modern injection systems, cooling & lubrication systems and supercharging to optimize the thermal efficiency and emission standards.
CO4: Explore new generation hybrid engines and basics of electric vehicles to acquire modern industry standards.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Engine Fundamentals	Classification and working of basic engine types: 2-stroke & 4-stroke Engines, SI & CI Engines, Engine Nomenclature, Performance parameters; Measurement of speed, torque, fuel consumption, IHP, BHP and FHP, SFC, thermal efficiency,	**5**
2 Fuel Air Cycle & Actual Cycle	Review of Air Standard Cycles, Fuel-Air cycles: Assumptions, Effect of specific heat & Dissociation, Performance analysis of fuel air cycle. Actual cycles: Assumptions, Heat Loss, Time loss and Blowdown loss, Optimum spark advance	**6**
3 Fuels & Combustion	Fuels: classification and desirable characteristics, HCV and LCV, Rating of fuels, Alternative fuels. Combustion of fuels in S.I and C.I engines, Parameters influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Types of combustion chambers, Analysis of combustion product	**7**
4 Fuel Mixing, Injection and Ignition Systems	Fuel-Air mixing in SI Engines, Analysis of a simple carburetor, Disadvantages. Fuel injection systems: Working principle, Injection pumps and nozzles, electronic fuel injection system, MPFI systems, Ignition systems: ignition timing and spark advance, firing order.	**8**

5 Engine Cooling, Scavenging & Supercharging	Cooling and Lubrication: Properties of lubricating oil, Air and liquid cooling. Scavenging: ideal and actual, scavenging pumps, Supercharging and Turbo charging	**5**
6 Electric vehicles and Hybrid Engines	History, Components and General Layout of Electric vehicle (EV), EV classification, Comparison with IC Engine, Advantages and disadvantages of EV, Components and General Layout of Hybrid EV, Comparison with EV, Advantages and disadvantages of Hybrid EV.	5
Total Hours (36L)		

Text Books:

1. V. Ganesan, Internal Combustion Engines, The McGraw-Hill Companies.
2. M.L. Mathur and R.P. Sharma, A course in Internal Combustion Engines, Dhanpat Rai & Sons.
3. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Private Ltd.
4. Electric vehicle technology explained, James Larminie and John Lowry, Wiley.
5. Introduction to Hybrid vehicle system Modeling and control, Wei Liu, Wiley.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	-	1	1	-	-	1	2	2	2	3	2
CO2	2	1	3	2	-	2	2	1	-	1	2	2	2	2	2
CO3	3	3	3	3	2	1	1	-	-	1	3	3	2	2	2
CO4	2	1	2	2	3	3	3	1	-	1	2	3	2	3	2

COURSE NAME: KINEMATICS & DYNAMICS OF MACHINES
CODE: ME504
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3
Prerequisite: Physics

Course Outcomes: After successful completion of this course learners will be able to

CO1: Understand the kinematics and rigid- body dynamics of kinematically driven machine components
CO2: Understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
CO3: Design and analyse cam and gear basedmechanisms to generate specified output motion
CO4: Explore the mechanism of bearings and understand vibration-based systems

Course Contents:

Module	Syllabus	Contact Hrs
1– Mechanisms	Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms	6
2– Velocity & Acceleration	Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis component of acceleration- introduction to linkage synthesis three position graphical synthesis for motion and path generation	**8**
3– Cam Drive	Classification of cams and followers- Terminology and definitions- Displacement diagrams, Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers	**6**

4- Gear Drive	Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.	**6**
5- Friction & Bearings	Introduction to Bearing, Classification; Sliding contact bearing & Rolling Contact bearing, Lubrication in different bearing material, 'Balancing' in Mechanical components, Gyroscope.	**6**
6 - Vibration	Natural and Transverse vibration, Free and forced Vibration, Damping, Torsional vibration	**4**
Total Hours (36 L)		

Text Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East West Pvt. Ltd, New Delhi, 1988.

Reference Books:

3. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata Mc Graw Hill, 2009.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	1	-	-	-	-	-	-	2	1	2	-	-
CO3	2	2	2	-	2	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	3	2	2	-	3

COURSE NAME: REFRIGERATION & AIR CONDITIONING
COURSE CODE: ME505
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3

Prerequisite: Applied Thermodynamics

Course Outcomes: After successful completion of this course learners will be able to

CO1: Explain different types of Refrigeration cycles and its applications in multi compressor and multi evaporator systems.
CO2: Evaluate the selection and design of different components of Refrigeration systems
CO3: Interpret the knowledge of psychometric processes and air conditioning systems.
CO4: Design the air-conditioning system for a given conditions including refrigerating equipment as well as ducting systems.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Refrigerants	Classification of refrigeration systems, Refrigerants and their mixtures: properties and characteristics; Ozone depletion and global warming issues	**3**
2 VCRS	Advanced Vapor compression cycles Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems	**8**
3 VARS	Vapour Absorption Refrigeration System, Advanced absorption refrigeration systems and their components, Lithium bromide - water System; Aqua-ammonia systems.	**5**
4 ARS	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual air refrigeration cycle.	**5**
4 Air Conditioning	Review of Psychrometry and Air-conditioning processes- Comfort air conditioning and Cooling load calculations - Applications of AC systems	**10**
5 Duct Design	Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils, Duct Sizing & Design	**5**
Total Hours (36 L)		

Text Books:

1. Stocker & Jones, Refrigeration and Air Conditioning, McGraw Hill.
2. P. L. Ballaney, Refrigeration and Air Conditioning.

Reference Books:

3. R. C. Arora, Refrigeration and Air Conditioning, TMH.
4. Arora and Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	-	1	1	-	-	1	1	-	-	-	-
CO2	2	-	2	-	-	1	3	1	-	1	2	1	2	-	3
CO3	2	2	2	-	-	-	-	-	-	1	1	-	2	-	2
CO4	3	1	3	1	-	1	2	-	-	1	2	2	2	-	3

COURSE NAME: COMPOSITE MATERIALS
COURSE CODE: ME505B
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3
Prerequisite: Engineering Materials

Course Outcomes: After successful completion of this course learners will be able to

CO1: Know the structure and basic properties of composite and nano-composite materials.
CO2: Explore and understand the several methods of composite fabrication.
CO3: Predict the characteristics and performance of composite materials.
CO4: Apply varying composite materials in automotive, aerospace and other applications.

Module	Syllabus	Contact Hours
1	**Introduction to composites:** Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina-assumptions, macroscopic viewpoint, generalized Hookes law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.	10
2	**Characterization of Composites:** Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, crossply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates	10
3	**Performance Analysis of Composites:** Analysis of laminated plates-equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies	8
4	**Fabrication and application of Composites:** Manufacturing of composite materials, bag molding, compression molding, pultrusion, filament welding, other manufacturing processes, Industrial Application of Composite Materials	8
Total Hours (36 L)		

Text Books:
1. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.
2. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003),

Wiley-VCH Verlag GmbH Co. KgaA, Weinheim.
3. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Kidlington, Oxford OX5Lgb, UK.
4. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993) Chapman & Hall, London.
5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	-	-	-	-	1	-	-	2	-	2
CO2	2	-	1	2	1	-	-	1	-	1	2	1	2	-	2
CO3	2	2	2	1	1	1	-	-	-	1	1	1	2	-	2
CO4	2	1	2	2	1	1	-	1	-	1	2	3	2	-	2

COURSE NAME: FINITE ELEMENT ANALYSIS
COURSE CODE: ME505C
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDIT: 3
PREREQUISITE: MATHEMATICS III

Course Outcomes: After successful completion of this course learners will be able to

CO1: Understand the fundamental theory of the FEA method.
CO2: Develop the ability to generate the governing FE equations for systems governed by partial differential equations.
CO3: Apply the basic finite element methods for structural applications using truss, beam, frame, and plane elements.
CO4: Analyze the FE method and compare the results with FEA package like ANSYS.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Historical background, Relevance of FEM to design problems, Application to the continuum– Discretization, Matrix approach, Matrix algebra– Gaussian elimination, Governing equations for continuum, Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method	8
2.	One dimensional problems: Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements- Shapes functions, Applications to axial loadings of rods– Extension to plane trusses, Bending of beams– Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing, Example Problems.	8
3.	Two dimensional problems– scalar variable problems: Finite element modeling– CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer, Examples	4
4.	Two dimensional problems– vector variable problems: Vector Variable problems, Elasticity equations– Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples	8
5.	Isoparametric elements for two dimensional problems: Natural coordinates, Iso parametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress	6

	calculations, Examples.	
6.	Computer implementation: Pre-processor, Processor, Post-processor. Discussion about finite element packages.	2
Total		**36**

Text Books:

1. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, Prentice Hall-India, New Delhi.
2. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India.
3. C.S. Krishnamoorthy, Finite Element Analysis, TMH.
4. K-J. Bathe, Finite Element Procedures, Prentice Hall.
5. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Elsevier.
6. J.N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	2	3	-	-	1	-	-	-	3	3	-	-
CO2	2	3	-	3	2	-	-	1	-	-	-	2	3	-	-
CO3	3	3	-	2	2	-	-	1	-	-	-	2	3	-	-
CO4	-	-	-	1	2	-	-	1	-	-	-	2	3	-	2

COURSE NAME: HEAT TRANSFER LAB
COURSE CODE: ME591
CONTACT: 0: 0: 3
CREDITS:1.5

Prerequisite: Heat Transfer

Course Outcomes: After successful completion of this course learners will be able to

CO1: Evaluate the problems involving steady state conduction in simple geometries.
CO2: Determine the convective heat transfer for free and forced convection related problems.
CO3: Differentiate radiation capabilities of black and grey surfaces by practical observation
CO4: Analyze the effectiveness of heat exchanger and develop skills for industrial design solutions.

List of Experiments:

1. Determination of the thermal conductivity and specific heat of given objects
2. Determination of the thermal conductivity of insulating materials
3. Determine the overall heat transfer coefficient of the composite wall
4. Determination of thermal conductivity of liquid.
5. Determination of the convective heat transfer coefficient for flow over a heated plate
6. Determination of the average theoretical and experimental value of heat transfer coefficient for forced convection.
7. Determination of the emissivity of a given sample.
8. Determination of the Stefan Boltzmann constant for radiation heat transfer.
9. Determination of the effectiveness of a shell and tube heat exchanger.
10. Determination of the LMTD, effectiveness of parallel and counter flow heat exchanger.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	-	-	-	-	-	2	1	3	2	-	1	-
CO2	2	-	3	-	-		1	-	2	2	3	2	-	2	2
CO3	2	-	1	-	-	1		-	2	1	3	2	-	1	-
CO4	2	-	1	1	-	-	-	-	2	2	3	2	-	2	3

COURSENAME: MANUFACTURING TECHNOLOGY LAB
COURSECODE:ME592
CONTACTS: 0: 0: 3
CREDITS:1.5

Prerequisite: Manufacturing Technology

Course Outcomes: After successful completion of this course learners will be able to
CO1: Demonstrate operation such as Turning, Facing, Threading, gear cutting on Centre Lathe and milling.
CO2: Analyze the cutting forces during metal cutting.
CO3: Understand principle of engineering metrology, measurement standards and instruments
CO4: Perform the job of an inspector and help the industries to produce quality products.

List of Experiments:

Experiment No.	Description
1	Taper turning and external thread cutting using lathe
2	Contour milling using vertical milling machine
3	Spur gear cutting in milling machine
4	Measurement of cutting forces in Milling/ Turning process
5	Use of Tool Maker's Microscope
6	Comparator and sine bar
7	Surface finish measurement equipment
8	Bore diameter measurement using micrometer and telescopic gauge
9	Use of Autocollimator

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	3	1	1	1	1	1	1	2	3	2	2	2	2
CO2	3	3	2	3	2	2	1	-	-	2	3	3	2	2	2
CO3	3	2	2	1	-	1	-	-	-	2	3	2	2	2	2
CO4	3	3	2	2	-	2	1	2	1	2	3	2	2	2	2

COURSE NAME: THERMAL ENGINEERING LAB
COURSE CODE: ME593
CONTACTS: 0: 0: 3
CREDITS: 1.5

Prerequisite: Applied Thermodynamics, Internal Combustion Engine

Course Outcomes: After successful completion of this course learners will be able to

CO1: Understand the practical operation of 2 stroke and 4 stroke I.C engines using valve timing diagram
CO2: Analyze the performance of multi cylinder engines with the variation of various performances like load and speed.
CO3: Determine the quality of Engine fuels by analyzing its calorific value.
CO4: Analyze the constituents of combustion products for emission characteristics related to public safety.

Course Contents:

Experiment No.	Description
1	Study of cut models of Two stroke and four stroke Petrol and Diesel Engines.
2	Study of valve timing diagram of Petrol & Diesel Engine.
3	Determination of flash point and fire point of sample oil.
4	Determination of calorific value of a fuel by Bomb calorimeter.
5	Performance Test of a Diesel Engine using Mechanical and Electrical dynamometer.
6	Morse Test on multi cylinder petrol engine by electrical break dynamometer.
7	Study of Boiler Cut Models
8	Determination of work input and efficiency of an air compressor

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	-	-	-	-	-	2	1	3	2	2	2	-
CO2	2	-	3	2	-	1	-	-	3	1	3	2	2	2	-
CO3	-	-	2	-	-	2	2	-	3	1	3	3	2	2	-
CO4	-	3	2	-	-	2	3	2	3	1	3	3	2	2	-

COURSE NAME: REFRIGERATION & AIR CONDITIONING LAB
COURSE CODE: ME594A
CONTACTS: 0: 0: 3
CREDITS: 1.5

Prerequisite: Applied Thermodynamics, Refrigeration & Air Conditioning.

Course Outcomes: On successful completion of the course, the learner will be able to,

CO1. Demonstrate a domestic refrigerator and identify its important components.

CO 2. Analyze the performance parameters of a vapor compression-based refrigeration system

CO 3. Observe the components of a basic air conditioning setup and operate it to analyze its performance index.

CO 4. Recognize the components of a thermoelectric refrigeration setup and measure its coefficient of performance useful in future project applications.

Course Contents:

List of Experiments

1. Study of a Domestic Refrigerator.
2. Study of a room (window type) Air Conditioner.
3. Study of a room (split type) Air Conditioner.
4. Determination of C.O.P of a vapour compression refrigeration system.
5. Experiment in an Air Conditioning Test Unit; Determination of bypass factor and plotting of the cooling – dehumidification process on a psychometric chart.
6. Performance test of thermoelectric refrigeration system

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	-	-	1	-	-	3	2	3	2	-	-	2
CO2	1	-	2	-	-	-	-	-	3	2	3	3	1	1	2
CO3	1	-	2	-	1	1	1	-	3	2	3	2	1	1	2
CO4	1	-	1	-	1	-	2	-	2	2	3	3	2	-	3

.

COURSE NAME: COMPOSITE MATERIALS LAB
COURSE CODE: ME594B
CONTACTS: 0: 0: 3
CREDITS: 1.5

Prerequisite: Composite Materials Theory Course

Course Outcomes: Upon successful completion of this course, students will be able to
1) Learn to manufacture Fiber reinforced Polymer Composites.
2) Measure mechanical Properties of Fiber reinforced Polymer Composites
3) Fiber reinforced Polymer Composites
4) Analyze the FE method and compare result with FEA package like-ANSYS.

List of Experiments:

1. Preparation of Fiber reinforced Polymer Composites
2. Study of Tensile strength and young's modulus of FRP composites
3. Study of Hardness of FRP composites
4. Study of drop weight impact testing
5. Preparation of Al-SiC composites by stir casting method
6. Study of microstructure, hardness and density of Al-SiC composite
7. Study of Tensile strength of Al-SiC composites
8. Environmental Testing (Humidity and temperature)

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	2	-	-	-	1	1	2	3	1	3-	-	2
CO2	2	3	-	3	2	-	-	1	1	2	3	1	2	-	3
CO3	3	3	2	2	2	-	-	1	1	2	3	3	2	-	2
CO4	-	-	3	1	3	-	-	1	1	2	3	3	2	-	3

COURSE NAME: FINITE ELEMENT ANALYSIS LAB
COURSE CODE: ME594C
CONTACTS: 0: 0: 3
CREDITS: 1.5
Prerequisite: Mathematics I & II
Course Outcomes: Upon successful completion of this course, students will be able to
1) Understand the fundamental theory of the FEA.
2) Generate the governing FE equations for systems governed by partial differential equations.
3) Use the finite element methods for structural applications using truss, beam frame, and plane elements.
4) Analyze the FE method and compare result with FEA package like-ANSYS.

Course Contents:
1. Introduction to software employed in modelling and analyzing of structural problems.
2. Ten (10) relevant problems shall be modelled and analyzed using ANSYS software.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	2	-	-	-	1	1	2	3	1	2	-	-
CO2	2	3	-	3	2	-	-	1	2	2	3	1	2	2	-
CO3	3	3	2	2	2	-	-	1	1	2	3	3	-	3	-
CO4	-	-	3	1	3	-	-	1	2	2	3	3	2	-	2

COURSE NAME: INTELLECTUAL PROPERTY RIGHT
COURSE CODE: MC501
CONTACTS: 2L:0T:0P
TOTAL CONTACT HOURS: 24
CREDIT: 0

Prerequisite*:* None

Course Outcomes: On successful completion of the course, the learner will be able to:
CO1: Explain fundamental aspects of Intellectual property Rights to students
CO2: To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
CO3: To disseminate knowledge on copyrights and its related rights and registration aspects
CO4: To disseminate knowledge on trademarks and registration aspects
CO5: To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
CO6: To aware about current trends in IPR and Govt. steps in fostering IPR

Course Content

Module 1: 4 hrs

Overview of the IPR: Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - International organizations. agencies and treaties,

Module 2: 4 hrs

Patents- Trips Definition, kind of inventions protected by patent-Patentable and Non patentable inventions. Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Le8al requirements for patents — Granting of patent - Rights of a patent-exclusive right. Patent application process: Searching a patent- Drawing of a patent- Filing of a patent- Types of patent applications- Parent document: specification and Claims.

Registration Procedure, Rights and Duties of Patentee, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties

Module 3: 4 hrs

Trademarks- Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - trade mark registration processes.

Module 4:

Copyrights- 4 hrs

Right and protection covered by copyright - Law of copy rights: Fundamental of copyright law. originality **of material,** rights of reproduction, rights to perform the worth publicly, copy

right ownership issues, obtaining copy right registration, notice of copy right. International copy right law. Infringement of Copyright under Copyright Act

The Role arid Liabilities of lPRs in India - Cyberlaw issues: Criminal law. data safety, online privacy. Health privacy, Freedom of expression and human rights, net neutrality, national security.

Module 5: **4 hrs**

Geographical Indication of Goods: Types, why and how GI need protection and GI laws. Indian GI act. Industrial Designs: protection. Kind of protection provided by industrial designs. Integrated Circuits

Module 6: 4 hrs

India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes IPR – Career Opportunities in IP - IPR in current scenario with case studies

Text book:

1. Fundamentals oflP for Engineers: K.Bansl& P.Bansal
2. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
3. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Reference book:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1	2	3			2		2	3	3	1	2	3
CO2	3	1		1			1		1		3	3		1	
CO3	3		1	2	3			2		2	3	3	1	2	3
CO4	3	1		1			1		1		3	3		1	
CO5	3		2		2	3				2	3	3	2		2
CO6	3	2		1				2	2		3	3		1	

3rd Year 2nd Semester

Sl.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	HSMC	HSMC604	Economics for Engineers	2	0	0	2	2
2	PC	ME601	Design of Machine Elements	3	0	0	3	3
3	PC	ME602	Power Plant Engineering	3	0	0	3	3
4	PE	ME603	Professional Elective-II A. Robotics B. Computational Fluid Dynamics C. Fluid Power control	3	0	0	3	3
5	PE	ME604	Professional Elective-III A. Materials Handling B. Computer Aided Design C. Nuclear Power Generation & Supply	3	0	0	3	3
6	OE	ME605	Open Elective-I A. Mechatronics Systems B. Data Base Management System C. Electrical Machines	3	0	0	3	3
B. PRACTICAL								
7	PC	ME691	Design Lab	0	0	3	3	1.5
8	PE	ME692	Professional Elective-II Lab A. Robotics Lab B. Computational Fluid Dynamics Lab C. Fluid Power control Lab	0	0	3	3	1.5
9	OE	ME693	Open Elective-I Lab A. Mechatronics Systems Lab B. Data Base Management System Lab C. Electrical Machines Lab	0	0	3	3	1.5
10	PROJECT	PR691	Minor Project II	0	0	3	2	1
11	PROJECT	PR692	Skill Development VI: Soft Skill & Aptitude-III	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC601	Constitution of India	3	0	0	3	0
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D.MOOCS COURSES**								
13	MOOCS COURSES	HM601	MOOCS COURSE-IV	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.0**

*After successful completion of MC601 a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET

COURSE NAME: ECONOMICS FOR ENGINEERS
COURSE CODE: HSMC604
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2
Pre-requisites: MATH – College Algebra, Pre-Calculus Algebra and Trigonometry.

Course Outcome(s): After successful completion of this course learners will be able to

CO1: Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.
CO2: Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.
CO3: Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
CO4: Evaluate the profit of a firm, carry out the break even analysis and employ this tool to make production decision.
CO5: Discuss and solve advanced economic engineering analysis problems including taxation and inflation.

Course Contents:
Module 1: Introduction[3L]
Managerial Economics-Relationship with other disciplines-Firms: Types, Objectives and goals-Managerial Decisions-Decision Analysis.
Module 2:**Demand and Supply Analysis**[5 L]
Demand-Types of demand-determinants of demand-Demand function-Demand Elasticity-Demand forecasting-Supply-Determinants of supply-Supply function-Supply Elasticity.
Module 3: Cost Analysis[5 L]
Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – PV ratio.
Module 4: **Elementary economic Analysis [4 L]**
Inflation-Meaning of inflation, types, causes, measures to control inflation.
National Income-Definition, Concepts of national income, Method of measuring national income.
Module 5: Financial Accounting [5 L]
Concepts and Definition of Accounting, Journal,Ledger, Trial Balance. TradingA/C, Profit& Loss A/C and Balance Sheet.
Module 6: Investment Decision[2L]
Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence. Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Text books:
1. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India
2. Principles of Economics, Deviga Vengedasalam; Karunagaran Madhavan, Oxford University Press.

Reference Books:

1. Engineering Economy by William G. Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
2. R.Paneer Seelvan, " Engineering Economics", PHI
3. Ahuja, H.L., "Principles of Micro Economics" , S.Chand & Company Ltd
4. Jhingan, M.L., "Macro Economic Theory"
5. Macro Economics by S.P. Gupta, TMH
6. Haniff and Mukherjee, Modern Accounting,Vol-1,TMG
7. Modern Economic Theory – K.K. Dewett (S.Chand)

CO-PO MAPPING:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	2	1	1	-	-	1
CO2	-	-	-	3	-	-	-	-	-	-	-	-	-	-	1
CO3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	1
CO4	-	-	-	-	-	-	-	-	-	-	2	2	-	-	1

COURSE NAME: DESIGN OF MACHINE ELEMENTS
COURSE CODE: ME601
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
PREREQUISITE: Rigid body Mechanics, Strength of Materials, Theory of Machine

Course Outcomes: After successful completion of this course learners will be able to
C01: Understand the use of codes, standards for designing.
CO1: Able to prevent failure under static and fluctuating load.
C03: Able to analyze the different kind of stresses, which generates due to the loading in different mechanical element.
CO2: Able to design different mechanical elements

Course Content

Module No.	Syllabus	Contact Hrs.
1.Fundamentals of design of machine elements	Theory of failures to prevent static failure; Design consideration under cyclic stresses; S-N Curve; Endurance limit; Design for Infinite cycle and finite cycles under cyclic loading; Uses of Stress concentration factor(k_t); Notch sensitivity; Theoretical stress concentration factor; Gerber line, Soderberg line, Goodman Line, Modified Goodman Line.	7
2.Design of Shaft and Bearings	Design of shafts under static and fatigue loadings, Design of shaft using ASME code, Analysis and design of sliding and rolling contact bearings	6
3. Design of transmission elements	Spur, helical, bevel and worm gears; static & dynamic load calculation, belt and chain drives	7
4. Design of springs	Helical compression, tension, torsional and leaf springs	4
5. Design of joints	Threaded fasteners, pre-loaded bolts and welded joints, joint efficiencies, Analysis and applications of power screws and couplings	6
6. Design of Clutch and Brakes	Analysis of clutches and brakes	6
Total Lectures: 36L		

Text Books:

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	-	1	-	-	-	1	1	1	1	3	3	2
CO2	2	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO3	1	3	3	3	-	-	1	-	-	-	-	-	2	3	2
CO4	2	3	3	3	2	1	-	1	-	1	2	2	2	2	2

COURSE NAME: POWER PLANT ENGINEERING
COURSE CODE: ME602
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS:3
Prerequisite: Applied Thermodynamics

Course Outcomes:

CO1: Explore minute details of all components of coal-based power plant including steam generation,fuel and ash handling equipment.
CO2: Understand the principle of steam and gas-based turbines to analyze their performance for a variety of design conditions.
CO3: Describe brief functionalities of Nuclear, Hydel and other renewable energy-based power plants.
CO4: Evaluate plant performance with the knowledge of plant economics.

Course Contents:

Module	Syllabus	Contact Hrs
1 Thermal Power Plant	Coal based thermal power plants, Coal properties, Combustion analysis, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers & Cooling Towers, Steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, Losses in boilers, boilers efficiency binary cycles and cogeneration systems.	**10**
2 Steam Turbine & Condensing Systems	Steam turbine- Major classification, Nozzles types and efficiency, Impulse turbine - velocity diagram, work done and blade efficiency. Pressure compounding and velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. Governing in Steam turbine. Condenser and Cooling Towers	**8**
4 Gas Turbine and Combined Cycle	Diesel Power Plant, Gas turbine and combined cycle power plants, components of gas turbine power plants, combined cycle power plants, Brayton Cycle – Analysis & Optimization. Integrated Gasifier based Combined Cycle (IGCC) systems.	**5**
5 Nuclear Power Plants	Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor, Pressurized Water Reactor, CANDU Pressurized Heavy Water Reactor, Fast Breeder Reactors, Gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	**5**
6 Hydel and Renewable Energy plants	Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.	**4**

7 Plant Economics	Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including wastedisposal options for coal and nuclear plants	**4**
TOTAL		**36L**

Text Books:

1. P.K. Nag, "Power plant Engineering," Tata McGraw Hill.
2. Arora and Domkundwar, "A course in Power Plant Engineering" Dhanpat Rai & Sons.
3. M. M. EI- Wakil, "Power plant technology," Tata McGraw - Hill.

CO– PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	3	2	1	-	-	3	2	2	2	3
CO2	2	2	3	1	3	1	2	1	1	1	2	3	3	2	2
CO3	2	1	2	1	3	1	2	1	-	1	1	2	2	2	2
CO4	3	3	3	2	2	1	1	2	1	1	2	3	3	2	3

COURSE NAME: ROBOTICS
COURSE CODE: ME603A
CONTACT: 3:0:0
TOTAL CONTACT HOURS:36
CREDITS:3
Prerequisite: Basic Electronics, mechanism, manufacturing technology.

Course Outcomes: Upon successful completion of this course, students will be able to
CO1: Understand the various robot structures and their workspace.
CO2: Learn about robot kinematics.
CO3: Analyze the different control drives in robot operation system.
CO4: Apply programming for controlling the robotic operation.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** Brief history of robotics; definition of robot; Main components of robot: manipulator, sensors, controller, power conversion unit; Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, joined; Classification of robot according to coordinate system: cartesian, cylindrical, polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach stroke:	**7**
2	**Robot kinematics:** Definition of Robot kinematics, Tool frame and base frame. Forward kinematics, Inverse kinematics, Describing position and orientation of an object in space, Homogenous transformation, Translational transformations, Rotational transformations, Denavit-Hartenberg representation.	**6**
3	**End effectors:** End effectors- classification- mechanical, magnetic, vacuum and adhesive gripper- gripper force analysis and design. Robot control- Unit control system concept- servo and non-servo control of robot joints, adaptive and optimal control.	**5**
4	**Robot actuators:** Definition; Characteristics: power to weight ratio, stiffness, compliance, reduction gears; Conventional actuators: hydraulic actuator, pneumatic actuator, electric motor, direct drive motor, stepper motor, servo motor; Special actuators: magnetostrictive, shape memory alloy, elastomer.	**4**
5	**Robot Sensors:** Sensor devices, Types of sensors- contact, position and displacement sensors, Force and torque sensors- Proximity and range sensors- acoustic sensors- Robot vision systems- Sensing and digitizing-Image processing and analysis.	**5**
6	**Robot Programming:** Robot language classification- programming	**4**

	methods- off and online programming- Lead through method-Teach pendent method- VAL systems and language, simple program.	
7	**Industrial Application:** Application of robots- Material handling- Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microbots- Recent developments in robotics- safety consideration.	**5**

Text Books:

1. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication, New Delhi, 1994.
2. M.P. Groover. Industrial Robotics Technology Programming and Applications, McGrawHill Book Co, Singapore, 1987.
3. S. K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2014.
4. Y. Koren, Yoram, Robotics for Engineers, McGraw-Hill Book Company, Singapore.
5. W. Stadler, Analytical Robotics and Mechatronics, McGraw Hill Book Co., 1995.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	-	-	-	1	1	-	2	2	1	2
CO2	2	1	1	2	1	-	-	1	-	1	2	3	2	2	3
CO3	2	2	2	1	1	1	-	-	-	-	1	3	2	1	2
CO4	2	1	2	2	1	1	-	1	-	-	2	3	2	2	3

COURSE NAME: COMPUTATIONAL FLUID DYNAMICS
COURSE CODE: ME603B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fluid mechanics, Thermodynamics, Heat Transfer

Course Outcomes: After successful completion of this course learners will be able to

1. Understand the conservation equations and boundary conditions of fluid flow for varying cases.
2. Analyze finite difference and finite volume methods of discretization
3. To introduce numerical modeling and its role in the field of fluid flow and heat transfer
4. Apply several computational solution methods based on finite element analysis
5. Understand the various discretization methods, solution procedures and turbulence modeling.

Course Contents:

Module	Syllabus	Contact Hours
1. Introduction	Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Boundary and initial conditions; overview of numerical methods	5
2. Finite Difference Technique	Finite difference methods; different means for formulating finite difference equation; Taylor series expansion; treatment of boundary conditions; boundary layer treatment; accuracy of f.d. method. Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.	8
3. Finite Volume Technique	Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.	5
4. Finite Element Methods	Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one- and two-dimensional elements; applications.	6
6.	Single and multilevel methods; predict or corrector methods; stability analysis; Applications to transient conduction and	6

Time integration Methods	advection-diffusion problems. Basics of numerical grid generation.	
7. Turbulence models and mesh generation	Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models	6
Total Hours (36 L)		

TEXT BOOKS:

1. ProdipNiyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition – 2007.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

REFERENCES:

1. Anil W. Date, "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005.
2. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.
3. Chung, T.J., "Computational Fluid Dynamics", Cambridge University, Press, 2002.
4. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
5. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
6. S.V.Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
7. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
8. John D.Anderson Jr, Computational Fluid Dynamics, McGraw Hill Book Company.

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	-	-	1	2	1	1	**2**	2	1	2
CO2	3	2	3	1	1	-	1	2	-	1	-	**3**	2	2	3
CO3	3	3	3	3	1	1	-	1	-	1	-	**2**	2	1	2
CO4	3	2	2	2	1	-	-	1	2	1	1	**3**	2	2	3

COURSE NAME: FLUID POWER CONTROL
COURSE CODE: ME603C
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3

Prerequisite: Fluid Mechanics, Basic Electronics

Course Outcomes: After successful completion of this course learners will be able to
CO1: Understand the working principle of hydraulic and pneumatic systems.
CO2: Analyze the performance of pumps and actuators used in control devices.
CO3: Apply hydraulic valves in different industrial application.
CO4: Design and evaluate fluid powered control circuits and express through proper drawing.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** Introduction to Fluid power; Hydraulic power generation and transmission. Applications and advantages; Components of a hydraulic and pneumatic system. Desired properties of a hydraulic fluid; advantage of mineral oil over water; definition of terms like pressure, head, force, density, specific gravity, kinematic and absolute viscosity, compressibility and incompressibility, Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation; hydraulic power of a cylinder.	**6**
2	**Hydraulic pumps, accumulators and intensifiers:** Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps. Accumulators: Types, selection/design procedure, applications of accumulators. Types of Intensifiers, Pressure switches/sensor, Temperature switches/sensor, Level sensor.	**6**
3	**Actuators**Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators. Application of cylinder through mechanical linkages; force, velocity and Power from a cylinder.	**7**
4	**Components and hydraulic circuit design Components** Classification of control valves, Directional Control Valves-symbolic representation, sliding spool, solenoid and pilot operated DCV, shuttle	**7**

	valve, and check valves. Pressure control valves – types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator	
5	**Pneumatic control circuits:** Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders – supply air throttling and exhaust air throttling. Signal Processing Elements: Use of Logic gates – OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates. Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).	**6**
6	**Electro- Pneumatic Control**Principles – signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application. Gives an overview of control systems associated with Electro hydraulic and pneumatic applications.	**4**
Total		**36 L**

Text Books:

1. Anthony Esposito, Fluid Power with applications, Prentice Hall international, 1997.
2. Ahmed Abu Hanieh, Fluid Power Control: Hydraulics and pneumatics, Cambridge International Science Publishing.
3. Andrew Parr, Hydraulics and pneumatics, Jaico Publishing House, 2003.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	-	-	-	-	1	1	-	-	1	-
CO2	2	-	1	2	1	-	-	1	-	1	2	1	2	2	1
CO3	2	2	2	1	1	1	-	-	-	1	1	1	-	1	1
CO4	2	1	2	2	1	1	-	1	-	1	2	3	2	2	-

COURSE NAME MATERIALS HANDLING
COURSE CODE: ME604A
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS:3
Prerequisite: Manufacturing Technology, Kinematics & Dynamics of Machines.

Course Outcomes: After successful completion of this course learners will be able to
CO1: Understand the importance of material handling and plant layout.
CO2: Study the design procedures of various material handling equipment & component.
CO3: Analyze the variety of load & selection of material handling system based on application through general analysis procedure.
CO4: Apply the fundamentals of load lifting, automation and auxiliary equipment in material handling with proper design consideration.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** Elements of Material Handling System-Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment.	4
2	**Study of Systems & Material Handling Equipment:** Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks, etc. **Auxiliary Equipment:** Descriptive specification and use of – (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) positioners like elevating platform, ramps, universal vice; (v) ball table (ii)	10
3	**Selection of Material Handling Equipment**: Factors affecting for selection; Material Handling Equation; Choice of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials	8
4	**Hoisting Equipment:** Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley	10

	system-simple vs. multiple pulley; Load handling attachments: hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist, (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane. Safety precautions.	
5	**Robotic Handling:** Materials handling at workplace; Major components of a robot; Applications of robotic handling.	**4**

Text Books:

1. S. Ray, Introduction to Materials Handling, New Age Int. Pub.
2. T. K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors.
4. J.A. Apple, Material Handling System Design, John Wiley & Sons

CO – PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	1	3	1	1	-	2	2	2	-	1	1	1	-	2
CO2	3	2	1	-	-	1	-	1	-	-	1	2	2	-	1
CO3	3	2	3	2	1	2	1	1	-	-	1	2	1	-	1
CO4	3	1	3	2	1	2	1	1	1	-	1	3	2	-	2

COURSE NAME: COMPUTER AIDED DESIGN
COURSE CODE: ME604B
CONTACT HOUR: 3:0:0
CREDITS: 3
TOTAL LECTURES: 36L
Prerequisite: Engineering Drawing, Mathematics

Course Outcome: After successful completion of this course learners will be able to
CO1. Apply geometric transformations and projection methods in CAD.
CO2. Develop geometric models to represent curves.
CO3. Develop surface models for engineering design.
CO4. Model engineering components using solid modelling techniques for design.

Course Contents:

Module	**Syllabus**	**Contact Hrs.**
Module 1 Introduction	Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, geometric modelling.	3
Module 2 Transformations in Geometric Modeling	Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.	5
Module 3 Projections	Projective geometry, transformation matrices for Perspective, Axonometric projections, Orthographic and Oblique projections. Implementation of the projection formulations using computer codes.	6
Module 4 Introduction to Geometric Modeling for Design	Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling	4
Module 5 Curves in Geometric Modeling for Design	Differential geometry of curves, Analytic Curves, PC curve, Ferguson's Cubic Curve, Composite Ferguson, Curve Trimming and Blending. Bezier segments Bernstein polynomials, Composite Bezier. B-spline basis functions, Properties of basic functions, NURBS. Conversion of one form of curve to other. Implementation of the all the curve models using computer codes in an interactive manner	7
Module 6 Surfaces in Geometric Modeling for Design	Surfaces entities (planar, surface of revolution, lofted etc.). Free-form surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon's). Implementation of the all the surface models using computer codes.	6

Module 7 Solids in Geometric Modeling for Design	Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modeling methods in CAD softwares. Data Exchange Formats and CAD Applications:	5
TOTAL		**36**

TEXT BOOK:

1. Michael E. Mortenson, Geometric Modelling, Tata McGraw Hill, 2013.
2. A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005.
3. Rogers, David F., An introduction to NURBS: with historical perspective, Morgan Kaufmann Publishers, USA, 2001.
4. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.

CO– PO Mapping:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	1	3	1	2	-	2	2	2	1	1	2	1	-	2
CO2	3	2	1	-	2	1	-	1	-	1	1	2	2	-	2
CO3	3	2	3	2	3	2	1	1	-	1	1	2	1	-	2
CO4	3	1	3	2	3	2	1	1	1	1	1	3	2	-	2

COURSE NAME: NUCLEAR POWER GENERATION AND SUPPLY
COURSE CODE: ME604C
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDIT: 3
Prerequisite: Physics, Chemistry, Heat Transfer, Power plant Engineering.

Course Outcomes: After successful completion of this course learners will be able to

1. Detailed knowledge of nuclear reactor types and associated systems
2. Analyze variety of nuclear power plants based on fission and fusion.
3. Evaluate the safety assessments and waste management.
4. Design and simulate equivalent conditions for practical problem solving.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Basics of a Nuclear Power Generation, energy from fission and fusion reactions	4
2.	**Systems in nuclear reactor:** Reactor fuel system: Natural and enriched fuels, sources, merits and demerits of different fuels for reactor use, fabrication, handling of fuels and irradiated fuels, fuel management, storage, reprocessing of irradiated fuels. Reactor shutdown systems: Materials for reactor control and choices, liquid vs. solid shut down systems, design aspects Primary heat transport (cooling) system: Heat generation and distribution, Coolant characteristics, Selection of coolants, Coolant Circuit, Core thermal hydraulics, Decay heat removal system. Reactor structure: Core composition, Reflector, Reactor vessel, Safety vessel, Shielding. Thermal, biological, Shield cooling system, Moderator system: Materials, Selection, Design consideration, Circuit, Radioactivity aspects. Cover gas system: Purpose, Selection of material, Design considerations, Circuit. Reactor regulating system: Purpose, Methodology, Design considerations, Actuating mechanism.	10
3.	**Reactor Design:** Principles, Safety classifications, Seismic quality group, Loading considerations under normal operations, design basis accidents such as earthquake, loss of coolant accident (LOCA), blackout, flood, missiles, operator error, Safety features for server accidents, standards, software, verifications etc.	6
4.	**Nuclear power plants:** Types. Thermal reactors: BWR, PWR, PHWR, GCR, APWR, AHWR etc. Fast reactors Breeders; Fusion power; Off-land NPPs - space power unit, nuclear ships, submarines. Economics of NPPs: Various costs, ROI, Sizing, Operational characteristics.	8
5.	**Radiation protection:** Radiation hazard, Exposure pathways, dose unit, measurement, CRP Radioactive Waste Management: Waste categorization,	4

	Generation, Handling of wastes.	
6.	Reactor Stages and Safety Assurances: Nuclear safety assurance.	4
TOTAL		**36L**

Text Books:

1. A.K. Raja, A.P. Srivastava & M. Dwivedi, An Introduction on Nuclear Engineering,
2. Glasstone & Sesons- Nuclear Engineering.
3. P.K. Nag., Nuclear Power Plant, Power Plant Engg. (Steam & Nuclear)
4. Arora & Domkundwar, A course in Power Plant Engg.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	2	2	-	-	1	1	3	1	-	2
CO2	2	1	1	2	-	2	2	-	-	1	1	2	2	-	1
CO3	2	2	3	1	-	3	3	-	-	1	1	3	1	-	1
CO4	1	1	1	1	2	3	3	-	-	1	1	3	2	-	2

COURSE NAME: MECHATRONIC SYSTEMS
COURSE CODE: ME605A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36L
CREDIT: 3
Prerequisite: Fluid Mechanics, Basic Electronics

Course Outcomes After successful completion of this course learners will be able to
CO1: Describe Mechatronics systems and have an overview of the types of actuators.
CO2: Distinguish between various sensors, transducers, actuators and their applications.
CO3: Understand the basic concept of microprocessor.
CO4: Interpret various signal conditioning units, amplifiers, logic gates and their role in Programmable logic controllers.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1. Introduction	Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;	**3**
2. Sensors and transducers	classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.	**6**
3. Drives and Actuators	Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;	**5**
4. Smart Materials	Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc. Mechatronic systems such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	**6**
5. Micro-mechatronic systems	Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.	**6**
6. Introduction to Microprocessors	Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Programmable peripheral interface (8255). Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller. Use of Ladder	**6**

	diagram	
Total Hours (36 L)		

Text Books:

1. W. Bolton, Mechatronics, Pearson Education
2. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
3. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
4. A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited

Reference Books:

1. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall
2. N.P. Mahalik, Mechatronics, Tata McGraw Hill Publication
3. K. Ogata, Modern Control Engineering, Prentice Hall.
4. B.C. Kuo, Automatic Control Systems, Prentice Hall.

CO-PO MAPPING:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	1	-	-	-	-	-	-	1	1	1	2
CO2	3	1	2	-	2	-	1	-	-	-	1	2	2	1	1
CO3	2	-	1	-	2	-	-	-	-	-	-	2	3	2	2
CO4	3	2	2	-	3	-	1	-	-	-	3	2	3	2	1

COURSE NAME: DATABASE MANAGEMENT SYSTEM
COURSE CODE: ME605B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites:

1. Logic of programming language
2. Basic concepts of data structure and algorithms

Course Outcomes: After successful completion of this course learners will be able to

CO1. Apply geometric transformations and projection methods in CAD.

CO2. Develop geometric models to represent curves.

CO3. Develop surface models for engineering design.

CO4. Model engineering components using solid modelling techniques for design.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Introduction	Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.	**3**
2 Entity-Relationship and Relational Database Model	Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, case study on E-R Model. Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.	**9**
3 SQL and Integrity Constraints	Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.	**6**
4 Relational Database Design	Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF , Case Study	**6**

5 Internals of RDBMS	Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols; two phase locking, Dead Lock handling	**6**
6 File Organization & Index Structures	File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes	**6**
Total Hours (36 L)		

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings
Publishing. Company.

Reference Books:

1. Jain: Advanced Database Management System CyberTech
2. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
3. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B. Navathe, Addison Wesley Publishing Edition
4. Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman Publishers.
5. Ullman JD., "Principles of Database Systems", Galgottia Publication.

CO-PO MAPPING:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	3	-	-	-	-	-	3	3	1	1	2
CO2	-	3	3	3	3	-	3	3	-	-	3	3	2	1	1
CO3	3	-	-	-	-	2	2	2	3	3	3	3	3	2	2
CO4	3	3	2	2	2	-	-	2	2	2	-	3	3	2	1

Course Name: **Electrical Machines**
Course Code: **ME605C**
Course Credit: **3:0:0**
Contact Hours: **36 L**
Credit: 3
Pre-requisite Basic Electrical Engineering

Course Outcome: After successful completion of this course learners will be able to

CO1: Formulate and then analyze the working of any electrical machine under loaded and unloaded conditions.
CO2: Understand and explain the principle of operation and performance of DC machine, Three Phase Induction Motor, Synchronous Machine and Fractional kW Motors.
CO3: Analyze the response of DC machine, Three Phase Induction Motor, Synchronous Machine and Fractional kW Motors.
CO4: Troubleshoot the operation of DC machine, Three Phase Induction Motor, Synchronous Machine and Fractional kW Motors.
CO5: Analyze given require specification of electrical machine and select a suitable measuring instrument for a given application.

Course Content

Module No.	Syllabus	Contact Hrs
1 DC Machines	EMF generated in the armature, OCC and Voltage build-up in d.c. generator - concept of critical resistance & critical speed. External Characteristics. Armature reaction - function of Interpoles & Compensating windings. Commutation process, Concept of back e.m.f. - Speed & Torque equation of d.c. motor, Speed control of DC motor, Losses and Efficiency, Application of d.c. Machine	**9**
2 3-Phase Induction machine	Construction of 3-phase induction motor. Production of rotating magnetic field (concept only) - Working principle of 3-phase induction motor. Concept of synchronous speed & slip. Phasor diagram (at no-load & running condition). Equivalent circuit - No-load and Blocked rotor test. Torque equation. Torque-slip characteristic. Power flow in 3-phase induction motor (Numerical). Speed control & Braking of Induction motor. Starting methods of 3-phase induction motor – DOL, Auto-transformer & Star-Delta starter. Industrial application of 3-phase Induction motor	**10**

3 Synchronous Machines	Construction & Types of synchronous machines. Method of excitation system. Working principle of synchronous machines - generator & motor modes. Armature reaction at different power factor - concept of synchronous reactance. Theory of salient pole machine, Two reaction theory Voltage regulation by synchronous impedance method (with Numerical). Synchronous machine connected to infinite bus, Synchronization of two or more alternators and an alternator with infinite bus. Load sharing between them. Principle of operation of synchronous motor- its starting techniques - Damper winding & Hunting. 'V' Curves – Synchronous condenser.	**10**
4 Fractional Kilowatt motors	Single phase Induction motor: Construction, Double revolving field theory. Starting methods, Speed - torque characteristics & Application Principle of operation & Application of Stepper motors Principle of operation of Welding Transformer	**7**
	Total	**36L**

Text Books:

1. P.S. Bhimra, Electrical Machinery, Khanna Publishers.
2. D.P. Kothari & I.J Nagrath, Electric machines, Tata Mc Graw-Hill Publishing Company Limited.
3. P.K. Mukherjee & S. Chakrabarty, Electrical Machines, Dhanpat Rai Publication.

Reference Books:

1. Bhag S. Guru and H.R. Hiziroglu, Electric Machinery & Transformers, Oxford University press.
2. R.K. Srivastava, Electrical Machines, Cengage Learning.
3. Alexander S Langsdorf, Theory of Alternating Current Machinery, Tata Mc Graw Hill.
4. M.G. Say, The performance and Design of Alternating Current Machines, CBS Publishers & Distributors.
5. Irving L Koskow, Electric Machinery & transformer, Prentice Hall India.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	-	-	-	-	-	1	-	-	1	1	2
CO2	2	2	2	2	-	-	-	-	-	1	-	1	2	1	1
CO3	2	2	1	2	-	-	-	-	-	1	-	1	3	2	2
CO4	2	-	1	1	-	-	-	-	-	-	-	1	3	2	1

COURSE NAME: DESIGN LAB
COURSE CODE: ME691
CONTACTS: 3P
CREDITS: 2
Prerequisite: Theory of machines, Dynamics of Machine Theory, Strength of Material, Design of Machine element.

Course Outcomes: After successful completion of this course learners will be able to

1. Identify different mechanical elements and the uses of those elements.
2. Analyze existing mechanical elements under static as well as dynamic loading.
3. Determine the endurance limit of rotating beam specimen, stress concentration factors by FEA
4. Design a mechanical element by using standards, codes

Course Contents:

List of Experiments
1. Study of different mechanical elements e.g Gear, Clutch, Brake, Bearing, Shaft, Spline, Coupling, Keys
2. Determination of Endurance Limit for a rotating beam specimen by using fatigue testing machine.
3. Introduction to CAE, FEA
4. Measurement of stress at a desired point on a deformed body e.g beam under static loading by using strain gauge.
5. Estimation of stress at point on a deformed body e.g beam under static loading by using CAE tool and comparison with the experimental result obtained through Exp. No. 4
6. Determination of Stress concentration factors for different types of discontinuities in mechanical element by FEA using CAE tool.

Course Articulation Matrix:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	3	2	1	-	-	-	-	3	2	3	2	1	1	2
CO2	-	1	2	-	-	-	-	-	3	2	3	3	2	1	1
CO3	-	1	3	-	1	-	-	-	2	2	3	2	3	2	2
CO4	-	1	3	-	-	-	-	-	2	2	3	3	3	2	1

COURSE NAME: ROBOTICS LAB
COURSE CODE: ME692A
CONTACTS: 0: 0: 3
CREDITS:1.5
Prerequisite: Basic of robotics and electronics

Course Outcomes: After successful completion of this course learners will be able to

CO1: Describe the configuration of a robotic system from its motion.
CO2: Analyze the control of robotic systems with the help of programs.
CO3: Apply different operation in robot.
CO4: Evaluate different application in industry.

List of Experiments:

Experiment No.	Description
1	Introduction to robot configuration
2	Demonstration of robot with 2 DOF, 3 DOF, 4 DOF
3	Study and selection of Gripper.
4	Programming exercise of robots for Pick and Place activity.
5	Color based pick and place operation using vision system
6	Few case studies of robot applications in industry

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	-	2	-	-	-	-	2	2	2	1	1	2
CO2	2	-	1	-	1	-	-	1	-	2	2	3	2	1	1
CO3	2	1	3	-	1	1	-	-	-	2	3	2	3	2	2
CO4	2	1	2	-	1	-	-	1	-	2	3	3	3	2	1

COURSE NAME: COMPUTATIONAL FLUID DYNAMICS LAB
COURSE CODE: ME692B
CONTACT: 3:0:0
TOTAL CONTACTHOURS:36
CREDITS: 3
Prerequisite: Fluid mechanics, Thermodynamics, Heat Transfer

Course Outcomes: After successful completion of this course learners will be able to

CO1. To create numerical modeling and its role in the field of fluid flow
CO2. To use the various discretization methods, solution procedures and
CO3. To solve turbulence modeling flow and heat transfer problems.

Course Contents:
1. CFD analysis of a fluid flow through pipe in FLUENT for at least 3 variety of inlet and outlet boundary conditions and prediction of pressure, temperature and velocity
2. CFD analysis of a fluid flow over an airfoil in FLUENT and prediction of lift and drag.
3. CFD analysis of Supersonic Flow over a Wedge.
4. CFD analysis of Flat Plat Boundary Layer
5. CFD analysis of Flow past a Cylinder
6. Analysis of a Turbomachinery using ANSYS CFX.

TEXT BOOKS:

1. Prodip Niyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition – 2007.
3. Ghosh dastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
4. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**2**	**2**	**2**	**3**	1	1	2
CO2	**3**	**2**	**3**	**1**	**1**	**-**	**1**	**2**	**-**	**1**	**3**	**3**	2	1	1
CO3	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**1**	**-**	**2**	**2**	**2**	3	2	2

COURSE NAME: FLUID POWER CONTROL LAB
COURSE CODE: ME692C
CONTACTS: 0: 0: 3
CREDITS: 1.5
Prerequisite: Fluid Power Control

Course Outcomes: After successful completion of this course learners will be able to

CO1: Demonstrate the devices such as pumps, compressor, valves, actuators and sensors etc.
CO2: Differentiate hydraulic and pneumatic circuits.
CO3: Apply fluid control valves in different industrial application.
CO4: Design and evaluate fluid powered control circuits and express through proper drawing.

List of Experiments:

Experiment No.	Description
1	Study of Basic hydraulic circuits for the working of single and double acting cylinder, hydraulic pump and hydraulic motor.
2	To Study of Basic pneumatic circuits for the working of single and double acting cylinder, Compressor.
3	To Study of control valve (PCV, DCV, FCV) in a circuit for the working of single and double acting cylinder in a hydraulic and pneumatic system.
4	To Studies of Circuits for the Use of different direction control valves and valve actuation in single and double acting cylinder, and multi actuation circuit.
5	To Study and perform of Speed control circuits. Different Metering methods Inlet & outlet flow control (meter-in& meter-out circuit).
6	To Study Hydraulic or Pneumatic Sequencing circuit with magnetic sensor with Clamp, Direction Control Valves (Manual/External/Solenoid Operated), Flow Control Valves, Roller Lever Valve, Rapid Release Valve.
7	To perform AND & OR logic gate for a double acting cylinder using two cylinders by manual control.
8	To operate Two double acting cylinders, (Sequence of operation A+B+A-B-) using manual control & electrohydraulic control.
9	Study of circuit with cam operated pilot valves operating a pilot operated 4way direction control Valve or proximity/ limit switches, solenoid operated 4way direction control valve for Auto reversing circuit.

CO – PO Mapping:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	-	2	-	-	-	-	-	-	-	1	1	2
CO2	2	-	1	-	1	-	-	1	-	1	2	1	2	1	1
CO3	2	1	3	-	1	1	-	-	-	-	1	1	3	2	2
CO4	2	1	2	-	1	-	-	1	-	-	2	3	2	1	2

COURSE NAME: MECHATRONICS LAB
COURSE CODE: ME693A
CONTACTS: 0: 0: 3
CREDITS:2
Prerequisite: Fluid Mechanics, Basic Electronics, Mechatronics Theory

Course Outcomes: After successful completion of this course learners will be able to
CO1: Describe and demonstrate Mechatronics systems and overview of control systems & actuators.
CO2: Distinguish between various sensors, transducers and actuators and their applications.
CO3: To understand the basic concept of microprocessor and perform simple operations on it.
CO4: Identify various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers

List of Experiments
1. Open loop position control;
2. Closed loop position control using positional and velocity feedback;
3. Use of analog and digital servosystems,
4. Use of PID control;
5. Experiments on pneumatic drives and actuators;
6. Experiments on hydraulic drives and actuators;
7. Use of logic gates;
8. Programming on a 8085 Microprocessor training kit.
9. Programming on a PLC for simple control operations.

CO PO Mapping

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	2	-	1	-	-	-	2	1	2	-	-	-	-
CO2	1	-	2	-	1	-	-	-	-	1	3	1	2	-	1
CO3	1	-	2	-	2	-	-	-	-	1	2	-	-	-	-
CO4	2	-	3	-	1	-	-	-	-	1	3	-	1	-	1

COURSE NAME: DATABASE MANAGEMENT SYSTEM LAB
COURSE CODE: ME693B
CONTACT: 3P/WEEK
CREDITS: 1.5
Prerequisite:
1. Logic of programming language
2. Basic concepts of data structure and algorithms

Course Outcome(s): On completion of the course students will be able to
CO1: Understand the database management system and database language
CO2: Understand and apply the SQL queries related to management of data and transaction processing.
CO3: Explain about query processing techniques involved in query optimization
CO4: Understand PL/SQL programming, the concept of Cursor Management, Error Handling, Package and Triggers
CO5: Design and build the commercial database systems.

Course Contents:
Module 1 Conceptual Designing using ER Diagrams (Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.)
Module 2 Converting ER Model to Relational Model (Represent entities and relationships in Tabular form, Represent attributes as columns, identifying keys) and apply the normalization techniques.
Module 3 Creation of Tables using SQL- Overview of using SQL tool, Data types in SQL, Creating Tables
(along with Primary and Foreign keys), Altering Tables and Dropping Tables
Module 4 Practicing DML commands- Insert, Select, Update, Delete
Module 5 Practicing Queries using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, CONSTRAINTS etc., Practicing Sub queries (Nested, Correlated) and Joins (Inner, Outer and Equi).
Module 6 Practice Queries using COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING, VIEWS Creation and Dropping, Practicing on Triggers - creation of trigger, Insertion using trigger, Deletion using trigger, Updating using trigger
Module 7 Procedures- Creation of Stored Procedures, Execution of Procedure, and Modification of Procedure, PL/SQL, Cursors- Declaring Cursor, Opening Cursor, Fetching the data, closing the cursor.

CO PO Mapping

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	1	2	-	-	2	1	2	-	-	-	-
CO2	3	3	3	3	1	1	-	-	-	1	3	1	2	-	1
CO3	3	3	2	2	2	2	-	-	-	1	2	-	-	-	-
CO4	3	3	3	3	1	1	-	-	-	1	3	-	1	-	1
CO5	3	3	3	3	3	2	1	1	1						

COURSE NAME: ELECTRICAL MACHINES LAB
COURSE CODE: ME693C
CONTACT HOUR: 3 HR./WEEK
SEMESTER: 3
Prerequisite: Electrical Machines Theory

Course Outcome: On completion of the course students will be able to
1. Formulate and then analyze the working of any electrical machine under loaded and unloaded conditions.
2. Analyze the response of DC machine, Three Phase Induction Motor, Synchronous Machine and Fractional kW Motors.
3. Troubleshoot the operation of DC machine, Three Phase Induction Motor, Synchronous Machine and Fractional kW Motors.

Course Content:
At least 8 (eight) of the following experiments to be conducted.
1. Study of the characteristics of a separately excited d.c. generator.
2. Plot the O.C.C. of a d.c. generator & find the critical resistance.
3. Perform load test of d.c. shunt motor to determine efficiency and study the different characteristics of d.c. shunt motor.
4. Perform load test of d.c. series motor to determine efficiency and study the different characteristics of d.c. series motor.
5. Determine the efficiency of a D.C. motor by Swinburn's test.
6. Study different type of starting of 3 phase induction motor & their comparison.
7. Perform No-load test and Blocked-rotor test on 3-phase induction motor & draw the equivalent circuit from the two tests.
8. Study of performance of three phase squirrel- cage Induction motor –determination of Iron-loss, friction & windage loss.
9. Study the effect of capacitor on the starting and running condition of a single-phase induction motor.
10.Perform the load test on 3-phase induction motor and to study the performance characteristics of the motor.
11. Plot V-curve & inverted V-curve of the synchronous motor.

CO PO Mapping

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	-	-	-	-	-	1	3	3	-	1	-
CO2	2	2	2	2	-	-	-	-	-	1	2	2	2	-	1
CO3	2	2	1	2	-	-	-	-	-	1	3	2	1	1	2

COURSE NAME: CONSTITUTION OF INDIA
COURSE CODE: MC501
CONTACTS: 2L:0T:0P
TOTAL CONTACT HOURS: 24
CREDIT: 0
PREREQUISITE: NONE

Course Outcomes:
CO1: Identify and explore the basic features and modalities of Indian constitution.
CO2: Differentiate and relate the functioning of Indian parliamentary system at the centre and state level.
CO3: Differentiate the various aspects of Indian Legal System and its related bodies.

Course Content

Module 1: Introduction: 4L
"Constitution"- Historical Background of the Constituent Assembly, Indian Constitution and its Salient Features, the Preamble of the Constitution.

Module 2: Fundamental Rights, Fundamental Duties, Directive Principles of State Policy: 8L
The Right to Equality
The Right to Freedom: I (Article 19)
The Right to Freedom: II (Articles 20, 21 and 22)
The Right against Exploitation
The Right to freedom of Religion
Cultural and Educational rights
The Right to Property
The Right to Constitutional Remedies
The Directive Principles
Fundamental Duties

Module 3: Union Government and its Administration 6L
Structure of the Indian Union, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 4: The Machinery of Government in the State 6L
Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges
State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Text / Reference Books:

1) Indian Constitution by D.D.Basu, The Publisher, LexisNexis
2) Constitution of India by Subhas C Kasyap, Vitasta Publishing
3) The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
4) Indian Constitution Text Book - Avasthi, Avasthi, Publisher: LAKSHMI NARAIN AGARWAL

CO-PO Mapping:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	2	-	2	-	3		1	3	3	2	3	
CO2	3	2		1	--	1	-	2	2	3	3	3	-	2	2
CO3	3	-	1		-	3	-	2		1	3	3	3	-	1

4th Year 1st Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	HSMC	HSMC705	Industrial Management	2	0	0	2	2
2	PC	ME701	Advanced Manufacturing Technology	3	0	0	3	3
3	PE	ME702	Professional Elective-IV A. Automobile Engineering B. Tribology C. Maintenance Engineering D. Turbomachinery	3	0	0	3	3
4	OE	ME703	Open Elective-II A. 3D Printing and Design B. Internet Of Things C. Operation Research D. Microprocessor in Automation	3	0	0	3	3
5	OE	ME704	Open Elective-III A. Electric Vehicles B. Industrial Instrumentation C. Biomechanics & Biomaterials D. Cyber Security	3	0	0	3	3
B. PRACTICAL								
6	PC	ME791	Advanced Manufacturing Lab	0	0	0	3	1.5
7	OE	ME792	Open Elective-I Lab	0	0	3	3	1.5
8	PROJECT	PR791	Major Project-I	0	0	0	4	2
9	PROJECT	PR792*	Industrial Training / Internship	0	0	0	0	1
10	PROJECT	PR793	Skill Development VII: Seminar & Group Discussion	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
11	MC	MC781	Entrepreneurship & Innovation Skill	0	0	3	3	0
TOTAL CREDIT WITHOUT MOOCS COURSES								**20.5**
D.MOOCS COURSES**								
12	MOOCS COURSES	HM701	MOOCS COURSE-V	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**24.5**

*After successful completion of MC781, a student will acquire 3Units of mandatory course knowledge as mandated by AICTE.

***Collective Data from 3rd to 6th Semester (Summer/Winter Training during Semester Break & Internship should be done after 5th Semester or 6th Semester). All related certificates to be collected by the training/internship coordinator(s).**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

COURSE NAME: INDUSTRIAL MANAGEMENT
COURSE CODE: HSMC705
CONTACT HOUR: 2:0:0
TOTAL CONTACT HOUR- 24
CREDITS: 2

Prerequisites: NIL

Course outcome: On successful completion of the course learners will be able to
CO1: To recall and identify the relevance of management concepts.
CO2: To apply management techniques for meeting current and future management challenges faced by the organization
CO3: To compare the management theories and models critically to solve real-life problems in an organization.
CO4: To apply principles of management in order to execute the role as a manager in an organization.

Course Content:

Module No.	Syllabus	Contact Hrs.
1	Management Concepts: Definition, roles, functions and importance of Management, Evolution of Management thought-contribution made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow.	4
2	**Planning and Control:** Planning: Nature and importance of planning, - types of planning, Levels of planning - The Planning Process. – MBO, SWOT analysis, McKinsey's7S Approach. Organizing for decision making: Nature of organizing, span of control, Organizational structure –line and staff authority. Basic control process -control as a feedback system – Feed Forward Control – Requirements for effective control – control	4
3	**Group dynamics**: Types of groups, characteristics, objectives of Group Dynamics. Leadership: Definition, styles & functions of leadership, qualities for good leadership, Theories of leadership.	4
4	**Work Study and work measurement:** Definition of work study**,** Method Study Steps, Tools and Techniques used in the Method Study and Work Measurement Time Study: Aim & Objectives, Use of stopwatch procedure in making Time Study. Performance rating, allowances and its types. Calculation of Standard Time. Work sampling.	4
5	**Marketing Management**: Functions of Marketing, Product Planning and development, Promotional Strategy.	2
6	**Quality management**: Quality definition, Statistical quality control, acceptance sampling, Control Charts –Mean chart, range chart, c chart, p chart, np chart, Zero Defects, Quality circles, Kaizen & Six Sigma, ISO - 9000 Implementation steps, Total quality management.	6

Text Books:

1. Essentials of Management, by Harold Kooritz& Heinz Weihrich Tata McGraw
2. Production and Operations Management-K. Aswathapa, K. Shridhara Bhat, Himalayan Publishing House

References:

1. Organizational Behavior, Stephen Robbins Pearson Education, New Delhi
2. New era Management, Daft, 11th Edition, Cengage Learning
3. Principles of Marketing, Kotlar Philip and Armstrong Gary, Pearson publication

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1									3		3		1		
CO2						2		3	3		3	3		3	
CO3									2		3	3		2	
CO4						2			3		3				3

COURSE NAME: ADVANCED MANUFACTURING TECHNOLOGY
COURSE CODE: ME701
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Manufacturing Process.

Course Outcomes: On successful completion of the course learners will be able to
CO1: Learn the basics of automation and its application in flexible manufacturing systems.
CO2: Understand the principle of CNC machines and learn their programming language.
CO3: Evaluate the process parameters involved in machining process and analyze their effect on surface finish achieved in various nonconventional processes.
CO4: Get an overview of rapid prototyping and use of 3D printing.

Course Contents

Module No.	Syllabus	Contact Hrs.
1	Introduction to Advanced Manufacturing Technology Manufacturing Systems and Automation: Job shop, Flow lines, Transfer lines, Project shop, Continuous processes, Cellular manufacturing system, Flexible Manufacturing System. Automation: (i) degree of automation and their justified application in different levels of production (ii) benefits and draw backs of employing automation (iii) examples of conventional non-automatic, semi-automatic and automatic machine tools (iv) extent of automation in transfer machines Integrated Manufacturing System: Steps involved in implementation, forming the linked-cell factory, Introduction to Robotics for its implementation in manufacturing	10
2	Basic systems of NC and CNC machines: coordinate system, control – open loop and closed loop, dimensioning – absolute and incremental CNC machine tools ; structure and working principle machining centre (MC) – characteristics and applications. Control of tool – work travel, point – to – point and contouring, interpolation – linear and circular Part programming for NC, CNC and MC systems, Codes used, sequential steps, examples; part programming for machining in CNC lathes, drilling machines and milling, Computer aided part programming, advantages, programming languages, statements in APT, examples	8
3.	Non Traditional Manufacturing -Advantages, classification, characteristics Abrasive Jet Machining (AJM): principle, material removal rate Water Jet Machining, Applications, Advantages and limitations. Ultrasonic Machining (USM): Working principle, Influence of Process	12

	parameters, Applications. Plasma Arc Machining- principle, applications. Chemical Machining- Blanking, Design factors, advantages and disadvantages. Electro-Chemical Machining, Applications. Electrical Discharge Machining (EDM), Wire-cut EDM: working principle, Dielectric fluid, Advantages & Disadvantages. Electron Beam Machining Principle and Applications. Die sinking. Laser Beam Machining (LBM): Characteristics of Ruby laser, Carbon Dioxide laser, Welding Heat treating, cladding. Hybrid Machining	
4.	Rapid Prototyping- Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slice the STL File, Layer by layer construction, Clean and finish. Principles, systems, relative advantages and applications of the common RP methods; (i) stereo lithography (SLG) (ii) selective laser sintering (SLS) (iii) fused deposition modeling (FDM) (iv) laminated objects manufacturing (LOM) (v) 3-D Inkjet Printing	6

Text Books:

1. Fundamentals of Modern Manufacturing by Mikeel P. Grover– 3E Wiley
2. Automation, Production systems and CIM – M.P. Groover, Prentice Hall
3. non-conventional machining – P.K. Mishra, Narosa
4. Manufacturing science – Ghosh &Mullick, EWP

References:

5. Rapid prototyping – A. Ghosh, EW Press
6. Non-traditional Manufacturing Processes by Gary F. Benedict– Marcel Dekker
7. Micromaching of Engineering Material by McGeogh, J.A. – Marcel Dekker
8. Advanced Machining Process, Non-traditional and Hybrid Machining Processes by Hassan Abdel- Gawad El- Hofy – McGraw Hill, Mechanical Engineering Science

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3		2		2		3				1	2	2		
CO2	3	2	2		2		2				2	2		3	
CO3	2	1	1		2		2				1	1			3
CO4	2	2	2		3		2				2	2		2	3

COURSE NAME: AUTOMOBILE ENGINEERING
COURSE CODE: ME702A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Thermodynamics, Kinematics & Theory of Machines.

Course Outcomes: On successful completion of the course learners will be able to
CO1: Understand the basic layout of an automobile.
CO2: Explain the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3: Analyze the principles of transmission, suspension, steering and braking systems.
CO4: Study latest developments in automobiles.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** History & Development of Automobile. Various sub system of Automobile. **Prime Mover:** Engine for Two–Wheeler & Three-Wheeled vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carbureted engine, MPFI engine and Diesel engine, Lubrication and cooling system.	**5**
2	**Transmission System:** Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system. Flywheel & clutch. Gearbox sliding and constant mesh type, Automatic Transmission, Universal joint, Propeller shaft. Construction & function of differential, Different types of front & rear axles. Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.	**12**
3	**Suspension System** Conventional and independent suspension system, application. **Automotive Restraints:** Seat belt, automatic seat belt tightened system, collapsible steering column and air bags.	**5**
4	**Brake System:** Disc & drum brake, Hydraulic brake, Parking brake, Stopping distance.	**4**
5	**Electrical Systems:** Battery, generator, Ignition system, Starting system, lighting & signaling.	**4**
6	**Power Requirement:** Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.	**3**
7	**Modified Systems in Electric Vehicles**	**3**

Text Books:

1. Motor Vehicle by Newton, Steed and Garrette 2nd ed, Butter worth.
2. Automobile Mechanics by N.K. Giri, 7th ed, Khanna Publishers.
3. Automobile Mechanics by Heitner Joseph, East West Press.
4. K. Ramakrishna, Automobile Engineering, PHI Learning Pvt. Ltd., New Delhi, 2012.
5. Automobile Engineering by Amitosh De, Revised edition 2010, Galgotia Publication Pvt. Ltd.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	2	2	2	1	-	1	1	2	3	-	-
CO2	2	1	1	-	2	3	2	1	-	1	1	2	-	2	-
CO3	3	2	2	-	2	2	3	1	-	1	1	2	-	-	2
CO4	2	1	3	1	2	2	2	1	-	1	2	3	-	2	2

COURSE NAME: TRIBOLOGY
COURSE CODE: ME702B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Machine Design

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Become familiar with mathematical tools used to analyze Tribological processes.
CO2: Have awareness of Tribological issues in the design of machine components, such as rolling element bearings, journal bearings, thrust bearings, seals, and braking systems.
CO3: Become familiar with common anti-friction and anti-wear components.
CO4: Design a Tribological system for optimal performance.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Introduction: History, Industrial Importance. Engineering Surfaces: Properties and Measurement: Measurement Methods, Surface Profilometry, Statistical Description of Roughness.	4
2.	Surface Contact: Hertz contact theory, Greenwood-Williamson model, Elastic-plastic contact. Adhesion: Basic Models, Factors influencing Adhesion.	5
3.	Friction: Measurement Methods, Origin of Friction, Friction Theories – adhesion and ploughing, Mechanisms, Friction of Metals, Non-metallic Materials.	4
5.	Surface Engineering: Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD etc.	5
6.	Lubrication: Basic Equations for Fluid Film Lubrication. Hydrodynamic lubrication -Thrust and Journal bearings, Squeeze Film Bearings, Hydrostatic lubrication, Gas-Lubrication. Lubrication of rolling element bearings. Boundary lubrication – metal working lubrication, solid film lubrication. Hygiene of lubricants.	8
7.	Nanotribology: Measurement Tools: Surface Force Apparatus, Scanning Tunneling Microscope, Atomic / Friction Force Microscope.	4

Text Books:

1. P. Sahoo, Engineering Tribology, Prentice Hall-India, New Delhi, 2009.
2. B. Bhushan, Introduction to Tribology, Wiley, 2002.
3. G W Stachowiak and A W Batchelor, Engineering Tribology, Butterworth-Heinemann,2005.
4. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals of Tribology, Prentice Hall-India, 2005.
5. B C Majumdar, Introduction to Tribology of Bearings, S Chand & Co, 2012.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	-	-	-	-	1	-	1	-	2	-
CO2	2	1	1	1	-	-	-	-	-	1	-	2	3	-	-
CO3	3	2	1	2	-	-	-	-	-	1	-	1	-	2	-
CO4	2	1	2	1	-	-	-	-	-	1	-	2	-	2	3

COURSE NAME: MAINTENANCE ENGINEERING
COURSE CODE: ME702C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Strength of Material, Machine Design, Measurement and Instrumentation

Course Outcomes: On successful completion of the course learners will be able to
CO1: Get basic knowledge about types and procedure of maintenance, instruments and tools.
CO2: Understand organizational and economic structure of maintenance.
CO3: Evaluate of performance of tools associated with maintenance and lubrication.
CO4: Design maintenance tools for various applications like bearings, drives, pumps, piping etc.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment / systems, design for maintainability. Total Productive Maintenance (TPM): definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE)	8
2.	Organizational structures for maintenance: Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	4
3.	Economic Aspect of Maintenance: Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit- Procedure, tools, planning, reports.	4
4.	Function and use of Maintenance Equipment, Instruments & Tools: Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	6
5.	Lubrication: Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication	4

	devices, centralized lubrication system; Gasket, packing and seals;	
6.	Repair & Maintenance Procedures: Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine.	8

Recommended Books:

1. Mishra and Pathak, Maintenance Engineering and Management, PHI
2. Srivastava, Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi.
3. K. Venkataraman, Maintenance Engineering and Management, PHI

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1							1	1	2			3
CO2	2	2	1	1					1	1	2	3	2	1	
CO3	1	2	2	1	2				2	1	1	3		2	3
CO4	1	3	3	2	1	2	1		1	1	2	3			3

COURSE NAME: TURBOMACHINERY
COURSE CODE: ME702D
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
Credit: 3

Prerequisite: Fluid Mechanics and Fluid machinery

Course Outcomes: Upon successful completion of this course, students will be able to
CO1: Get Basic knowledge about rotary machines, nozzle, diffuser etc.
CO2: Understand about the calculation of efficiency, power etc. of steam turbines and hydraulic turbine.
CO3: Evaluate of efficiency, power required etc. of pumps and compressor
CO4: Design of various incompressible and compressible flow machines.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Classification: Incompressible and compressible flow machines; Radial, axial and mixed flow machines; Turbines vs pumps, fans and compressors. Applications: Water supply, ventilation, power generation, propulsion.	4
2.	Incompressible- Flow Machines: Euler Head Equation Hydraulic Turbines: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies. Pumps: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	10
3.	Compressible-Flow Machines: Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	9
4.	Dimensional Analysis: Similarity laws, Volume-flow, mass-flow head and power coefficients, Specific speed and machine selection; Pressure ratio, enthalpy ratio, Reynolds number, Mach number; Surge and choking.	5
5.	Testing and Performance Analysis: Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans and turbo-compressors. Cavitation– cause of cavitation and definition of Thoma's cavitation parameter.	8

Text Books:
1. S.M. Yahya, Turbine, Compressors and Fans.

2. J. Lal, Hydraulic Machines.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics & Fluid Machines, TMH.
4. M.M. Das, Fluid Mechanics & Turbo Machines, PHI, 2010.
5. R.K. Bansal, Fluid Mechanics & Machinery, Luxmi Publications.

References:

6. C. Ratnam, A.V. Kothapalli, Fluid Mechanics & Machinery, I.K. International Publishing House Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press.
8. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publication.
9. A.T. Sayers, Hydraulic and Compressible Flow Turbomachines.
10. R.K. Bansal, Fluid Mechanics and Hydraulic Machines.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	2	1	-	-	-	1	3	2		
CO2	3	2	-	-	-	-	-	-	1	-	1	3		2	
CO3	3	2	-	-	-	-	-	-	2	-	1	3		1	3
CO4	3	3	3	3	1	2	1	-	1	-	2	3	2		2

COURSE NAME: 3D PRINTING AND DESIGN
COURSE CODE: ME703A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Computer Aided Design & Drafting, Engineering Materials

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Develop CAD models for 3D printing and Import and Export CAD data.
CO2: Select a specific material for the given application.
CO3: Select a 3D printing process for an application.
CO4: Apply in product manufaturing using 3D Printing or Additive Manufacturing (AM).

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** Introduction to 3D Printing, Overview of additive manufacturing techniques, Additive v/s Conventional Manufacturing processes, Applications.	**6**
2	**CAD for Additive Manufacturing:** CAD Data formats, Slicing, Data translation, Data loss, STL format	**10**
3	**3D Printing:** Process, Equipment, Process parameter, Process Selection for various applications. Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	**8**
4	**Materials:** Polymers, Metals, Non-Metals, Process parameter, Process Selection for various applications. Various forms of raw material and their desired properties, Support Materials	**4**
5	**Core issues in 3D Printing:** Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting	**4**
6	**Post Processing: Requirement and Techniques** Support Removal, Sanding, Acetone treatment, polishing, Inspection and testing, Defects and their causes	**4**

Text Books:
1. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. Amitava Ghosh, Rapid Prototyping, McGraw hill Publishers.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	-	3	-	-	-	-	1	2	2	1	-	3
CO2	2	2	3	-	3	-	-	-	-	1	2	3	2	2	2
CO3	2	2	3	-	3	2	2	-	-	1	2	2	2	-	3
CO4	3	2	3	2	3	-	2	-	-	1	2	3	3	-	2

COURSE NAME: INTERNET OF THINGS
COURSE CODE: ME703B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36L
CREDIT: 3

Prerequisites: Fundamental knowledge in computer networking and wireless sensor network.

Course Outcome: After successful completion of this course learners will be able to

CO1: To understand the concepts of Internet of Things.
CO2: To analyse basic protocols in wireless sensor network.
CO3: To design IoT applications in different domain and be able to analyse their performance.
CO4: To implement basic IoT applications on embedded platform.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Fundamental of IoT	The Internet of Things, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Design challenges, Development challenges, Security challenges, Other challenges.	**7**
2 IoT and M2M	A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	**7**
3 Wireless Sensor Network	Network and Communication aspects, Wireless medium access issues, MAC protocol, routing protocols, Sensor deployment and Node discovery, Data aggregation and dissemination.	**6**
4 IoT Architecture	Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.	**7**

5 IoT Applications for Value Creations	Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, Real-time monitoring and control of processes - Deploying smart machines, smart sensors, and smart controllers with proprietary communication and internet technologies, Maximize safety, security and reliability through high precision automation and control, Advanced Metering Infrastructure (AMI), Smart Inverters, Remote control operation of energy consuming devices.	**5**
6 IoT Privacy, Security and Governance	Introduction, Overview of Governance, Privacy and Security Issues, Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in smart cities, Security.	**4**
Total Hours (36 L)		

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, ―Internet of Things (A Hands-on-Approach)‖, 1st Edition, VPT, 2014.
2. Francis daCosta, ―Rethinking the Internet of Things: A Scalable Approach to Connecting Everything‖, 1st Edition, Apress Publications, 2013.

Reference Books:

1. Cuno Pfister, Getting Started with the Internet of Things, O‟ Reilly Media, 2011, ISBN: 978-1-4493-9357-1
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice‖.

CO-PO MAPPING:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	3	-	-	-	-	-	1	2	-	2	-
CO2	2	3	3	3	3	-	3	3	-	-	1	2	3	-	-
CO3	1	-	-	-	-	2	2	2	3	3	1	2	-	-	2
CO4	1	3	2	2	2	-	-	2	2	2	-	2	-	3	-

COURSE NAME: BIOMECHANICS & BIOMATERIALS
COURSE CODE: ME703C
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Engineering Mechanics, Materials engineering

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Understand the fundamentals of biomechanics and its relation with human motion.
CO2: Apply a broad knowledge of different types of biomaterials including metals, polymers, ceramics and composites and their use in typical biomedical devices and clinical applications.
CO3: Design an implant using fundamental concept and modern engineering tools to develop hard tissue and soft tissue replacement materials by suitable material selection.
CO4: Analyze the design of various biocompatible implants and artificial organ to develop and improve Health Care Service to serve mankind and society.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Musculoskeletal Anatomy**: Basic Statics and Joint Mechanics (elbow, shoulder, spine, hip, knee, ankle)	6
2	**Basic Dynamics to Human Motion**: Review of linear and angular kinematics; Kinetic equations of motion; Work & energy methods; Momentum methods; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis Structure, Function, and Adaptation of Major Tissues and Organs	6
3	**Fundamental Strength of Materials in Biological Tissues**: Introduction to Viscoelasticity, Fundamentals of biomaterials science, Concept of biocompatibility, Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance, Disinfection and sterilization of biomaterials.	6
4	**Physico-chemical properties of biomaterials**: Mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties	6
5	**Elements in contact with the surface of a biomaterial**: Blood composition, plasma proteins, cells, tissues. Phenomena at the biointerfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body.	6
6	**Testing of biomaterials**: in vitro, in vivo preclinical and in vivo clinical tests. Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing.	6

Text Books:

1. Fundamentals of Biomechanics: D V Knudson, Springer.
2. Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, by Ozkaya and Nordin, Springer.
3. Biomechanics: Mechanical Properties of Living Tissues, by Fung, Springer
4. Basic Biomechanics of the Musculoskeletal System, by Nordin& Frankel, Barnes & Noble.
5. Biomaterials Science, An Introduction to Materials in medicine, Eds. B. D. Ratner and A. S. Hoffman, Academic Press, New York.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	-	-	-	-	-	-	-	-	2	-	3	-
CO2	2	2	1	1	-	-	-	-	1	-	-	3	-	-	3
CO3	1	2	2	1	2	-	-	-	2	-	-	3	3	-	-
CO4	1	3	3	2	1	2	1	-	1	-	2	3	-	2	3

COURSE NAME: MICROPROCESSOR IN AUTOMATION
COURSE CODE: ME703D
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: knowledge of digital electronics, knowledge of 8085 microprocessor

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Use data transfer techniques, describe architecture and operation of microcontroller 8051.
CO2: Develop assembly language programs using instruction set of 8051.
CO3: Design and develop microcontroller-based systems.
CO4: Explain various applications of microcontrollers.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**8086 and its Architecture** Intel 8086 processor, pin details for max. mode& min. mode. 8086 CPU architecture, bus interface unit & execution unit, pipelined architecture. Register organization & different addressing mode of 8086 Basic idea of some of the advanced features- concept of multi programming, interleaved memory, cache memory, multi-processing.	6
2	**Memory Organisation 8086:** Memory Addressing, Instruction set of 8086, Writing Assembly Language Programme	4
3	**Microcontroller 8051 Architecture** Difference between microcontroller & Microprocessor. Explain the Block diagram of the Architectural of 8051. 3.3 Explain the PIN Diagram features of the 8051 core. Explain the 8051 Programming Model. Explain the Port Structure & Operation, Timer/Counters, serial Interface & External memory	6
4	**8051 Addressing Modes &Instruction Set** Explain different addressing modes of 8051. Explain the different types of Instruction sets of 8051. Data Transfer, Arithmetic Operations, Logical Operations, Boolean Variable Manipulation, Program Branching	7
5	**8051 Assembly Language Programming Tools** Programs using Jump, Loop and Call Instructions, Time Delay Generation and Calculation. I/O Port Programming, Bit manipulation, Arithmetic Programs a. Unsigned Addition and Subtraction b. Unsigned Multiplication and Division c. Signed number concept and Arithmetic operations d. Logic Programs Programs using Logic and Compare Instructions a Programs using	9

	Rotate and Swap Instructions b. BCD and ASCII Application Programs, Counter / Timer Programming, Programming 8051 Timers Counter Programming, Serial Communication Programming a. Basics of Serial communication 8051 Connection to RS232, 8051 Serial Communication Programming, Interrupts Programming 8051 Interrupts a. Programming Timer Interrupts b. Programming External hardware Interrupts c. Programming the Serial Communication Interrupt d. Interrupt Priority in the 8051	
6	**Application** Stepper motor control Speed/position control of ac/dc motor Control of physical parameter like temp, pressure, flow etc	**4**

Text Books:

1. Microprocessor architecture, programming & applications. R.S. Gaonkar. Wiely.
2. Microprocessor& Microcontroller. N Senthil. Oxford University press.
3. Microprocessor and Microcontroller Kumar, Saravanan, Jeevananthan. Oxford University Press.
4. The 8051 Microcontroller &Embedded Systems Mazidi, Mazidi. PHI.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	-	-	-	-	-	-	1	1	-	-	3
CO2	2	1	1	-	-	1	-	1	-	-	1	1	2	-	-
CO3	3	2	2	-	2	2	1	1	-	-	1	1	-	3	-
CO4	2	1	3	1	1	2	1	1	-	-	2	3	-	2	-

COURSE NAME: ELECTRIC VEHICLES
COURSE CODE: ME704A
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of digital electronics, knowledge of 8085 microprocessor

Course Outcomes: On successful completion of the course, the learner will be able to:
CO1: Design and develop environment friendly electric Vehicle
CO2: Introduce application of smart grid and electric vehicle for conversion, control and automation
CO3: Understand controlling strategies of electrical vehicles.
CO4: Design and model electric vehicle systems and analyze the energy management strategies.

Course Contents:

Module	Syllabus	Contact Hours
1	Introduction: Electric vehicles (EV) development, past, present, and future, comparison with IC engine drive vehicles. Hybrid Electric Drivetrain, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains	8
2	Power Converters: Batteries, fuel cells, ultracapacitors. Power converters in EV. Different types of motors used in EV and their torque-speed characteristics, motor control techniques, high performance and efficiency optimized control, sensorless control.	10
3	EV modeling, Tier Characteristics, slip phenomena. Road condition estimation, driving force observer. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H.	10
4	EV motion control: model following control, optimum slip ratio control, direct yaw movement control, lateral motion stabilization. Fuel cell Vehicles, Hybrid Electric Vehicles (HEV), series, parallel and series-parallel (split) systems.	8

Text Books:
1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	3	2	3	1	-	-	1	2	2	3	-
CO2	2	1	2	-	3	2	3	1	-	-	1	2	-	-	2
CO3	3	2	2	-	3	2	3	1	-	-	1	2	2	-	2
CO4	2	1	3	-	3	3	3	1	-	-	1	3	-	2	-

COURSE NAME: INDUSTRIAL INSTRUMENTATION
COURSE CODE: ME704B
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDIT: 3
Prerequisite: Metrology and control system

Course Outcomes: Upon successful completion of this course, students will be able to
CO1: Obtain knowledge about different instruments used to measure pressure, temperature, flow, level of liquids and data acquisition etc.
CO2: Elucidate the construction and working of various industrial devices used to measure pressure, sound and flow
CO3: Explicate the construction and working of various industrial devices used to measure temperature, level, vibration, viscosity and humidity
CO4: Ability to analyze, formulate and select suitable sensor for the given industrial applications

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	**DISPLACEMENT** - LVDT, capacitive type transducers- Theory, applications. **ACCELEROMETER AND VIBROMETER** – Seismic instrument for acceleration measurement, velocity measurement, piezoelectric accelerometer, strain gauge accelerometer - theory and applications.	4
2.	**PRESSURE:** Absolute, gauge and vacuum pressures. **Elastic transducers:** Elastic diaphragm, Corrugated diaphragm, capsule type - relative merits and demerits, pressure ranges. Bourdon type pressure gauge- Theory, construction, installation, Pressure range, materials **Electrical Pressure gauges:** Strain gauges, Strain gauge half bridge and full bridge configurations, load cells **Vacuum gauges:** Mcleod gauge, thermal conductivity gauge, Calibration of pressure gauges, dead weight tester.	7
3.	**TEMPERATURE** **Non- Electrical gauges:** Liquid in glass thermometer, pressure thermometer. **Electrical gauges**- resistance temperature detector- 2, 3 and 4-wire configurations thermocouples and thermopiles, CJC, compensating wires, thermistor- theory, applications, relative merits and demerits, operating range. **Non-contact type temperature gauges** - total radiation pyrometer, optical pyrometer, temperature measuring problem in flowing fluid. Thermo well.	6
4.	**FLOW** **Variable head type flow meters**: orifice plate, Venturi tube, Flow Nozzle- Theory, construction, installation, tapping, selection methods. **Variable Area flow meter**: Theory, construction and installation	8

	Positive displacement type flow meters: Nutating disc, reciprocating piston, oval gear and helix type-Theory, construction and installation **Open channel flow measurements**: Different shapes of weirs and corresponding flow relations. **Electrical type flow meters:** Theory, installation details of electromagnetic flow meter, ultrasonic flow meter **Guide lines for selection of flow meters, Calibration of flow meters**	
5.	**LEVEL** **Non-Electrical gauges:** Sight glass type, Float type, displacer type, Air purge system-Theory, arrangements, relative merits and demerits **Electrical level gauge:** Resistive and capacitive types- Theory, arrangement, limitations **Nuclear radiation type, ultrasonic type Differential pressure type level measurement:** open and closed tanks Boiler drum level measurement.	6
6.	**DATA Acquisition, Transmission and Recording:** Application in open loop and close loop/ feedback control system - Cable transmission of analog voltage and current signals; cable transmission of digital data; Analog voltmeters and potentiometers; digital voltmeters and multimeters; Electromechanical XT and XY recorders; Analog Cathode-ray oscilloscope.	5
Total Contact Hrs 36L		

Text Books:

1. R K Jain, "Mechanical and Industrial Measurements", Khanna Publishers Co Ltd., New Delhi.
2. S.K.Singh, "Industrial instrumentation", TMH
3. RK Rajput, "Mechanical Measurements and Instrumentation", SK Kataria and Sons, New Delhi.
4. Donald P. Eckman, " Industrial Instrumentation", Wiley

References:

5. E O Doeblin, Measurement Systems- Application and Design, McGraw Hill
6. T G Beckwith and N L Buck, "Mechanical Measurements", Addition Wesley Publishing Company Limited.
7. J P Holman, "Experimental Methods for Engineers", McGraw Hill
8. Alan S Morris, "Measurement and Instrumentation Principles", Butterworth.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	2	1	-	2	2	-	2	-	-	2	-	3
CO2	2	1	2	-	-	1	2	1	1	1	-	-	-	3	-
CO3	3	2	-	2	1	-	2	2	-	1	-	-	3	-	-
CO4	3	-	2	-	-	2	-	3	-	2	-	-	-	2	-

COURSE NAME: OPERATIONS RESEARCH

COURSE CODE: ME704C
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDIT: 3
Prerequisite: Mathematics, LPP

Course Outcomes: On successful completion of the course, the learner will be able to

CODE	DESCRIPTION
CO1	Understand the characteristics of different types of decision-making environments to formulate and solve a real-world problem as a mathematical programming model.
CO2	Understand the theoretical workings of appropriate decision making approaches and tools to identify the optimal strategy in competitive world.
CO3	Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
CO4	Create Model of a dynamic system as a queuing model and compute important performance measures.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	**Introduction:** Brief history; different O.R. problems and techniques, Inventory control, Metaheuristics	2
2.	**Decision Theory:** Structure of the problem (decision table); Decision making under uncertainty with optimistic, pessimistic and average outcome criteria; Decision making under risk with expected value and expected loss criteria; Sequential decision using decision trees.	4
3.	**Linear Programming (LP):** Nature of LP problems through examples; Formulation of LP Problems; Graphical solutions of two decision variable problems; Properties of a solution to LP problems: convex solution space and extreme point solution; General form of LP model; Simplex method and its meaning; Steps of simplex method in tabular form; Solving LP problems by Simplex Method; Sensitivity analysis.	6
4.	**Project Evaluation:** PERT, CPM	2
5.	**Transportation & Assignment Problems:** Nature of a transportation or distribution problem; Tabular representation of a transportation problem; North-West Corner initial solution; Stepping stone method; Concept of dummy source or destination; Vogel's approximation method. Nature of an Assignment problem; Tabular representation; Hungarian method for solving assignment problems.	6
6.	**Network Analysis:** Network models and terminologies like arcs, nodes, paths, tree, spanning tree; shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.	5
7.	**Waiting Line Problems:** Structure of a waiting line System: Single-channel waiting line, process of arrivals, distribution of service times, queue discipline, steady stage operation; Single channel model with Poisson arrivals and exponential service time; Multiple channel model with	6

	Poisson arrival and exponential service times; Single channel model with Poisson arrivals and arbitrary service time (M/G/1); Economic analysis of waiting lines	
8.	**Non-Linear Programming:** Graphical illustration; Unconstrained optimization by (i) direct search method, (ii) steepest decent method; Constrained optimization by Lagrange multipliers; Integer linear programming by branch & bound technique; Dynamic programming problems and their characteristics.	5

Text Books:

1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. I.A. Taha, Operations Research: An Introduction, Pearson Publication
3. C.K. Musatfi, Operations Research, New Age International Publishers
4. S.S. Rao, Engineering Optimization, New Age International Publishers
5. R. Panneerselvam, Operations Research, Prentice Hall of India
6. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, The McGraw Hill Companies.

CO-PO MAPPING:

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1	2	-	3	2	3	1	-	-	-	2	2	-	3
CO2	3	1	2	-	3	2	3	1	-	-	-	2	-	2	-
CO3	1	2	-	-	3	2	3	1	-	-	-	2	-	3	-
CO4	1	2	2	-	3	3	3	1	-	-	-	2	-	-	3

COURSE NAME: CYBER SECURITY
COURSE CODE: ME704D
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite:

1. Familiarity in computer Networking.
2. Basic concepts about network security.

Course Outcome(s): On successful completion of the course, the learner will be able to
CO1 To understand the importance of professional practice, Law and Ethics in their personal lives and professional careers.
CO2 To acquire in depth knowledge of information technology act, security policies, and legal framework of right to privacy, data security and data protection
CO3 To develop the understanding of relationship between commerce and cyberspace
CO4 To be familiar with network security threats and countermeasures

Course Contents:
Module – 1: Introduction of Cybercrime [5]
Cybercrime, Forgery, Hacking, Software Piracy, Computer Network intrusion
Criminals plan attacks, passive attack, Active attacks, cyber stalking.
Module – 2: Cybercrime Mobile & Wireless devices[8]
Security challenges in mobile devices, cryptographic security for mobile devices, Attacks on mobile/cell phones, Theft, Virus, Hacking. Bluetooth; Different viruses on laptop.
Module -3: Tools and Methods used in Cyber-crime[7]
Proxy servers, Password checking, Random checking, Trojan Horses and Backdoors; DOS & DDOS attacks; SQL injection: Buffer over flow Attacks, Scripts Kiddies and Packaged Defense.
.
Module – 4: Cybercrime & Cyber security[6]
Phising methods, ID Theft; Online identity method Legal aspects, Indian laws, IT act, Public key certificate, Design of Cyber Security Policy of an Organization, Unicitral Model Law Jurisdiction to prescribe/Legislative Jurisdiction; Jurisdiction to adjudicate to enforce; Cyber Jurisdiction in Civil, Criminal & International Cases.

Module -5: Cyber Ethics[5]
The Importance of Cyber Law, Significance of cyber-Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Block chain Ethics.

Text Books:
1. Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India.
2. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
3. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).

4. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004)

Recommended Books:

1. Kenneth J. Knapp, "Cyber Security and Global Information Assurance:
Threat Analysis and Response Solutions", IGI Global, 2009.
2. Jonathan Rosenoer, "Cyber law: the Law of the Internet", Springer-verlag, 1997
3. Sudhir Naib, The Information Technology Act, 2005: A Handbook, OUP, New York,
4. Vasu Deva, Cyber Crimes and Law Enforcement, Commonwealth Publishers, New Delhi, (2003)

CO PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	**3**	**3**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**3**	**-**	**-**	**-**
CO2	**-**	**3**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO3	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: ADVANCED MANUFACTURING LAB
COURSE CODE: ME791
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Advanced Manufacturing

Course Outcomes: After successful completion of the course, the student would be able to
CO1: Program a CNC turning or milling machine for preparing a job.
CO2: Evaluate the process parameters involved in CNC machining
CO3: Analyze the principles of Robot programming and carryout hands-on practice
CO4: Study any nonconventional machining process and 3D printing.

Course Contents:
1) Programming on CNC Lathe.
2) Programming on CNC Milling Machine
3) Study of geometry of robot manipulator, actuators and grippers
4) Robot Programming.
5) Parametric Study of Electric-Discharge Machining
6) Study of AJM/USM/ECM

CO – PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	2	-	3	-	-	-	2	2	-	-	3
CO2	3	2	2	-	2	-	2	-	-	-	2	2	3	-	-
CO3	2	1	1	-	2	-	2	-	-	-	3	1	-	-	3
CO4	2	2	2	-	3	-	2	-	-	-	3	2	-	2	-

COURSE NAME: 3D PRINTING AND DESIGN LAB
COURSE CODE: ME792A
CONTACT: 0:0:3
CREDIT: 1.5
Prerequisite: 3D Printing Theory

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Develop CAD models for 3D printing and Import and Export CAD data.
CO2: Explore a 3D Printer and Setup a specific material for the given application.
CO3: 3D Print a product and measure its mechanical properties
CO4: Analyze defects and compare with conventional products

Course Contents:
- 3D Modelling of a single component.
- Assembly of CAD modelled Components
- Exercise on CAD Data Exchange.
- Generation of .stl files.
- Identification of a product for Additive Manufacturing and its process plan.
- Printing of identified product on an available AM machine.
- Post processing of additively manufactured product.
- Inspection and defect analysis of the additively manufactured product.
- Comparison of Additively manufactured product with conventional manufactured counterpart

SUGGESTED BOOKS

- Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
- Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
- Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
- CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	-	3	-	-	-	-	1	2	2	1	-	3
CO2	2	2	3	-	3	-	-	-	-	1	2	3	2	2	2
CO3	2	2	3	-	3	2	2	-	-	1	2	2	2	-	3
CO4	3	2	3	2	3	-	2	-	-	1	2	3	3	-	2

COURSE NAME: INTERNET OF THINGS (IOT) LAB
COURSE CODE: ME792B
WEEKLY CONTACT HOURS: 0:0:3
CREDIT: 1.5
Prerequisite: INTERNET OF THINGS

Course Outcomes: After completion of the course student will be able to
CO1. Use microcontroller based embedded platforms in IOT
CO2. Use microprocessor based embedded platforms in IOT
CO3. Use wireless peripherals for exchange of data.
CO4. Use of Devices, Gateways and Data Management in IoT.

Course Contents: List of Suggested Laboratory Experiments:

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee/GSM/Bluetooth module
3. Introduction to Raspberry PI platform and python programming
4. Interfacing sensors to Raspberry PI CO2
5. Communicate between Arduino and Raspberry PI using any wireless medium
6. Setup a cloud platform to log the data

CO-PO MAPPING:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	-	-	-	3	-	-	-	-	-	1	2	-	2	-
CO2	2	3	3	3	3	-	3	3	-	-	1	2	3	-	-
CO3	1	-	-	-	-	2	2	2	3	3	1	2	-	-	2
CO4	1	3	2	2	2	-	-	2	2	2	-	2	-	3	-

COURSE NAME: BIOMECHANICS AND BIOMATERIALS LAB
COURSE CODE: ME792C
WEEKLY CONTACT HOURS: 0:0:3
CREDIT: 1.5

Prerequisite: BIOMECHANICS AND BIOMATERIALS

Course Outcomes: After completion of the course student will be able to
CO1. Understand the fundamentals of biomechanics and its relation with human motion.
CO2. Apply a broad knowledge of different types of biomaterials including metals, polymers, ceramics and composites and their use in typical biomedical devices and clinical applications.
CO3. Design an implant using fundamental concept and modern engineering tools to develop hard tissue and soft tissue replacement materials by suitable material selection.
CO4. Analyze the design of various biocompatible implants and artificial organ to develop and improve Health Care Service to serve mankind and society.

Course Contents: List of Experiments
1. Hardness testing of biomaterials
2. Measurement of torque required to tap and screwing in jaw bone.
3. Determination of moment of inertia of human limb using dynamometer.
4. Measurement of viscosity of body fluid.
5. Determination of moment of inertia of human bone using compound pendulum method.
6. Surface roughness measurement of biomaterials.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	-	2	-	-	-	-	1	3	2	-	1	-
CO2	2	2	1	1	3	-	-	-	1	1	3	3	2	-	3
CO3	1	2	2	1	2	-	-	-	2	2	3	3	3	-	2
CO4	1	3	3	2	2	2	1	-	1	2	3	3	-	2	3

COURSE NAME: SENSOR LAB
COURSE CODE: ME792D
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: knowledge of digital electronics, knowledge of 8085 microprocessor

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Use data transfer techniques, describe architecture and operation of microcontroller 8051.
CO2: Develop assembly language programs using instruction set of 8051.
CO3: Design and develop microcontroller-based systems.
CO4: Explain various applications of microcontrollers.

Course Contents (List of Experiments):
1. Connect an LED to GPIO pin 25 and control it through command line.
2. Use DHT11 temperature sensor and print the temperature and humidity of the room with an interval of 15 seconds
3. Use Light Dependent Resistor (LDR) and control an LED that should switch-on/off depending on the light.
4. Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.
5. Switch on and switch of a DC motor based on the position of a switch.
6. Convert an analog voltage to digital value and show it on the screen.
7. Create a door lock application using a reed switch and magnet and give a beep when the door is opened.
8. Control a 230V device (Bulb) with Raspberry Pi using a relay.

Text Books:
1. Microprocessor architecture, programming & applications. R.S. Gaonkar. Wiely.
2. Microprocessor& Microcontroller. N Senthil. Oxford University press.
3. Microprocessor and Microcontroller Kumar, Saravanan, Jeevananthan. Oxford University Press.
4. The 8051 Microcontroller &Embedded Systems Mazidi, Mazidi. PHI.

CO – PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	-	-	-	-	-	-	1	1	-	-	3
CO2	2	1	1	-	-	1	-	1	-	-	1	1	2	-	-
CO3	3	2	2	-	2	2	1	1	-	-	1	1	-	3	-
CO4	2	1	3	1	1	2	1	1	-	-	2	3	-	2	-

COURSE NAME: ENTREPRENEURSHIP & INNOVATION SKILL
COURSE CODE: MC701
CONTACTS: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 0

Prerequisite: None

Course Outcomes: After the completion of the course, the students will be able to
CO1: Comprehend the role of bounded rationality, framing, causation and effectuation in entrepreneurial decision making.
CO2: Demonstrate an ability to design a business model canvas.
CO3: Evaluate the various sources of raising finance for startup ventures.
CO4: Explain the fundamentals of developing and presenting business pitching to potential investors.

Course Content

Module 1: **4 hrs**
Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioral; entrepreneurial challenges. Entrepreneurial Opportunities: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Module 2: **4 hrs**
Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, Effectuation and Causation; Advantage and Limitations of Entrepreneurship; Process of Entrepreneurship.

Module 3: **4 hrs**
Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Module 4: **4 hrs**
Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of Organisation, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Module 5: **4 hrs**
Entrepreneurs as problem solvers: Innovations and Entrepreneurial Ventures – Global and Indian; Role of Technology – E-commerce and social media; Social Entrepreneurship – Concept; Entrepreneurship – The Indian Scenario

Module 6: **4 hrs**
Project/Case Study: (Any One)

1. Visit of the District Industries Centre and prepare a report of activities and programs undertaken by them
2. Conduct a case study of any entrepreneurial venture in your nearby area.
3. Field Visit: Visit any business firm near your locality; interact with the owner of the business firm and prepare a field report on parameters like: type of business, scale of business, product/service dealing in, target customer, problems faced and measures to solve the faced challenges. 4. Know your State Handicraft and Handlooms as a means of economic activity

Text Books:

1. Bessant, J. (2003) High Involvement Innovation: Building and Sustaining Competitive Advantage Through Continuous Change. Chicester: John Wiley & Sons.
2. Bygrave, W and Zackarakis, A (2013) Entrepreneurship, 3rd Edition, John Wiley and Co. Drucker, P. (1999) Innovation and Entrepreneurship, Butterworth Heinemann, Oxford.
3. Fagerberg, J, Mowery, DC and Nelson, RR (2005) The Oxford Handbook of Innovation, Oxford University Press, NY.
4. Hisrich, R.D., Peters, M.P., and Shepherd, D. (2013) Entrepreneurship, McGraw-Hill Irwin, Boston.
5. Kuratko, D. (2013) Entrepreneurship: Theory, Process, and Practice, 9th Edition, Wiley online library.
6. Moore, Geoffrey, (1999) Crossing the Chasm, Harper & Collins.
7. Porter, ME, Competitive Advantage: Creating and Sustaining Superior Performance, Free Press, New York, NY, 1985

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	1	2	3	-	-	2	-	2	3	3	1	2	3
CO2	3	1	-	1	-	-	1	-	1	-	3	3	-	1	2
CO3	3	-	2	-	2	3	-	-	-	2	3	3	2	1	2
CO4	3	2	-	1	-	-	-	2	2	-	3	3	-	1	2

4th Year 2nd Semester

Sl No	Course Code	Course Code	Theory	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PE	ME801	Professional Elective-V A. Renewable Energy System B. Micro and Nano Manufacturing C. Gas Dynamics & Jet Propulsion D. Design of Transmission System	3	0	0	3	3
2	OE	ME802	Open Elective-IV A. Energy Conservation & Management B. Artificial Intelligence C. Block Chain D. Nanotechnology	3	0	0	3	3
3	OE	ME803	Open Elective-V A. Total Quality Management B. Safety & Occupational Health C. Industrial Pollution and Control D. Big Data Analytics	3	0	0	3	3
B. PRACTICAL								
4	PROJECT	PR891	Major Project-II	0	0	0	12	6
5	PROJECT	PR892	Grand Viva	0	0	0	0	1
C. MANDATORY ACTIVITIES / COURSES								
6	MC	MC801	Essence of Indian Knowledge Tradition	0	0	3	3	3 Units
TOTAL CREDIT								**16**

COURSE NAME : RENEWABLE ENERGY SYSTEMS
COURSE CODE : ME801A
CONTACT 3:0:0
TOTAL CONTACT HOURS : 36
CREDITS : 3

Prerequisite: Thermodynamics, Power Plant Engineering

Course Outcomes: On successful completion of the course, the learner will be able to
1.Create awareness among students about renewable sources of energy and application of renewable technologies in different areas of country.
2. Understand the working principle of various renewable energy technologies and systems like solar, wind, tidal and geothermal resources.
3. Explain the knowledge of Storage technologies from renewable energy sources.
4. Recognize the need and application of alternative biofuels in the field of power production.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Principles of Renewable Energy: The history and future of energy scenario, Sustainable Development and role of renewable energy, Scientific Principles of renewable energy. Review of principles: thermodynamics, fluid dynamics and heat transfer	4
2.	Solar radiation: (i) Sun-Earth geometry (ii) Extra-terrestrial Solar Radiation (iii) Measurement and estimation of solar radiation. Photovoltaic Generation: (i) Photon absorption at Silicon p-n junction (ii) Solar Cell (iii) Application and Systems. Designing a solar system and its implementation.	8
3.	Solar Water Heating: (i) Flat Plate Collectors: Heat Transfer analysis, Testing (ii) Evacuated Tube Collectors. Applications: (i) Air heaters (ii) Water Desalination (iii) Space Cooling (iv) Solar Concentrators (v) Solar ponds. Designing a solar heating system and its implementation.	7
4.	Wind Power: Wind Turbine types & Principles, Calculation of Power production from Wind mills, Betz Criteria	4
5.	Wave Power & tidal Power: Basic Concepts of Wave Power, Tidal Basins, Determination of energy conversion. Ocean Thermal Energy Conversion.	5
6.	Geothermal Energy: Location and Extraction, Petrothermal systems, Geothermal energy based vapor power cycles	4
7.	Biomass & Bio fuels: (i) Use of Biomass (ii) Classification & Use of Bio fuels. Energy Storage, Pumped Hydro Systems	4

Text Books:

1. Renewable Energy – G. Boyle, 2nd edition, OUP, 2010.
2. Renewable Energy Resources- Twidell, J & Weir, T, 2ndedition, Taylor & Francis, 2006.
3. Non-Conventional Energy Resources- B.H. Khan, T M H, 2010.
4. Non-Conventional Energy Sources- G.D. Rai, Khanna Publishers.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	-	2	3	-	-	-	-	3	1	1	1
CO2	2	-	2	-	-	2	3	-	-	-	-	2	2	1	1
CO3	2	-	1	-	-	2	3	-	-	-	-	2	1	1	2
CO4	-	-	-	-	-	2	3	-	-	-	-	3	2	1	2

COURSE NAME: MICRO AND NANO MANUFACTURING
COURSE CODE: ME801B
CONTACT: 3:0:0
CREDITS: 3
TOTAL LECTURES: 36L
Prerequisite: Traditional and Advanced Micromachining Processes

Course Outcome: On successful completion of the course, the learner will be able to
CO1. Understand different techniques for the synthesis and characterization of nanomaterials.
CO2. Design and analyze methods and tools for micro and nano-manufacturing.
CO3. Select micro and nano-manufacturing methods and identify key variables to improve quality of MEMS.
CO4. Choose appropriate industrially viable process, equipment and tools for a specific product.

Course Contents:

Module	**Syllabus**	**Contact Hrs.**
Module 1 Introduction	Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology, Scaling Laws/Sizing effects.	4
Module 2 Nano-materials Synthesis and Processing	Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation (CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing (GPC).	10
Module 3 Structural Characterization	X-ray diffraction,Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).	7
Module 4 Micro fabrication Techniques	Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining	7
Module 5 Nanofabrication Techniques	E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.	5
Module 6 MEMS devices and applications	Pressure sensor, Inertial sensor, Optical MEMS and RFMEMS, Micro-actuators for dual-stage servo systems.	3

TEXT BOOK:

1.Micromanufacturing, V. K. Jain (Ed.), CRC press, 2012.
2.Micromanufacturing & Nanotechnology, N. P. Mahalik, Springer.
3.Microfacbrication & Nanomanufacturing, Mark J. Jackson, CRC press.
4.Introduction to Micromachining, V. K. Jain (Ed.), Narosa publisher, 2010.

CO – PO Mapping:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	2	-	-	-	-	-	-	1	-	1	2	-	2
CO2	2	-	3	2	-	-	-	-	-	1	-	2	2	2	3
CO3	2	-	3	2	2	-	-	-	-	1	-	2	1	-	2
CO4	3	-	2	2	2	-	-	-	-	1	-	2	2	2	3

COURSE NAME: GAS DYNAMICS & JET PROPULSION
COURSE CODE: ME801C
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fluid Mechanics, Thermodynamics.

Course Outcomes: On successful completion of the course, the learner will be able to
CO1. Understand the basics of compressible flow.
CO2. Analyze compressible flow characteristics in constant and variable area ducts.
CO3. Apply the knowledge of shock theories in complex engineering situations.
CO4. Evaluate jet and rocket propulsion techniques applicable in aerospace industries.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	COMPRESSIBLE FLOW - FUNDAMENTALS Energy and momentum equations for compressible fluid flows - various regions of flows - reference velocities - stagnation state - velocity of sound - critical states - Mach number – critical Mach number - types of waves - Mach cone - Mach angle - effect of Mach number on flow.	6
2.	FLOW THROUGH VARIABLE AREA DUCTS Isentropic flow through variable area ducts- T-s and h-s diagrams for nozzle and diffuser flows - Area ratio as a function of Mach number - Mass flow rate through nozzles and diffusers - Effect of friction in flow through nozzles.	7
3.	FLOW THROUGH CONSTANT AREA DUCTS Flow in constant area ducts with friction (Fanno flow) – Fanno curves and Fanno flow equation - variation of flow properties - variation of Mach number with duct length. Isothermal flow with friction in constant area ducts. Flow in constant area ducts with heat transfer (Rayleigh flow) - Rayleigh line and Rayleigh flow equation - variation of flow properties - Maximum heat transfer.	6
4.	NORMAL AND OBLIQUE SHOCKS Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.	9
5.	PROPULSION Jet Propulsion: Aircraft propulsion - types of jet engines – energy flow through jet engines- performance of turbo jet engines - thrust - thrust power - propulsive and overall efficiencies – thrust augmentation in turbo jet engine - ram jet, pulse jet and turboprop Engines. Space Propulsion: Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion –Terminal and characteristic velocity - Applications.	8

Text Books

2. YAHYA. S.M. - "Fundamental of compressible flow"- New Age International (p) Ltd. - New Delhi 1996.
3. PATRICH.H. OOSTHVIZEN-WILLIAM E. CARSCALLEN- "Compressible fluid flow"- McGraw-Hill- 1997
4. COHEN. H. - ROGERS R.E.C AND SRAVANAMUTOO- "Gas turbine theory"- Addison Wesley Ltd. - 1987.
5. GANESAN. V. - "Gas Turbines"- Tata McGraw-Hill- New Delhi- 1999

Reference Books

6. RATHAKRISHNAN.E- "Gas Dynamics"- Prentice Hall of India- New Delhi- 2001
7. HILL.D and PETERSON .C, Mechanics & Thermodynamics of propulsion - Adisson Wesley Publishing Company, 1999.
8. G.P. Sutton- "Rocket Propulsion Elements "- John Wiley- 1986- New York.
9. ZUCROW N.J Principles of Jet Propulsion and Gas Turbines - John Wiley Newyork, 1970

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	3	1	1	1	1	3	2	3	1
CO2	2	1	2	1	2	2	3	1	1	1	1	2	1	2	2
CO3	2	1	1	1	2	2	3	1	1	1	1	2	1	2	3
CO4	1	1	1	1	3	2	3	1	2	1	2	3	1	2	3

COURSE NAME: DESIGN OF TRANSMISSION SYSTEMS
COURSE CODE: ME801D
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: Rigid body Mechanics, Strength of Materials, Theory of Machine, Design of machine elements

Course Outcomes: On successful completion of the course, the learner will be able to
CO1: Learn the concepts of design to belts, chains and rope drives.
CO2: Understand the concepts of design to spur, helical gears, worm, bevel gears
CO3: Apply the concepts of design to gear boxes
CO4: Design cams, brakes and clutches.

Course Content

Module No.	Syllabus	Contact Hrs.
1	**DESIGN OF FLEXIBLE ELEMENTS** Design of Flat belts and pulleys – Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets	6
2	**SPUR GEARS AND PARALLEL AXIS HELICAL GEARS** Speed ratios and number of teeth-Force analysis -Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears	8
3	**BEVEL, WORM AND CROSS HELICAL GEARS** Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.	7
4	**GEAR BOXES** Geometric progression – Standard step ratio – Ray diagram, kinematics layout -Design of sliding mesh gear box – Design of multi speed gear box for machine tool applications – Constant mesh gear box – Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.	7
5	**CAMS, CLUTCHES AND BRAKES** Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes – external shoe brakes – Internal expanding shoe brake	8
Total Lectures: 36L		

Text Books:

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	2	-	2	-	-	-	1	1	2	1	2	2	1
CO2	2	3	1	2	-	-	-	-	-	1	3	2	1	3	1
CO3	1	3	3	2	-	-	1	-	-	1	2	2	2	2	2
CO4	2	3	3	3	2	1	-	1	-	1	2	3	1	2	3

COURSE NAME: ENERGY CONSERVATION & MANAGEMENT
COURSE CODE: ME802A
TOTAL LECTURES: 36L
CREDIT: 3
CONTACT HOUR/WEEK (L:T:P) : 3:0:0

Prerequisite: Engineering Thermodynamics, Power Plant Engineering

Course Outcomes: On successful completion of the course, the learner will be able to
CO 1: Obtain knowledge about energy conservation policy, regulations and business practices
CO 2: Design to improve the thermal efficiency by designing suitable systems for heat recovery and co-generation
CO 3: Analyze the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure
CO 4: Evaluate the cost- benefit analysis of various investment alternatives for meeting the energy needs of the organization

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	The Energy Resources; Finite & Renewable Sources	4
2.	The Need for Energy Conservation- estimation of Finite fuel resource; Hubbert's model for oil reserve	3
3.	Waste Heat Recovery; Waste Heat Exchangers; Commercial Waste Heat Recovery Devices- Recuperators, Regenerative Heat Exchangers, Heat Pipes	3
4.	Industrial Energy Conservation- Industrial Insulations; Case Studies for HVAC, Air Compressor, Mechanical Handling & Other Systems, Study of energy efficient methods	8
5.	Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering	8
6.	Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing -ESCO concept	6
7.	Energy and environment, air pollution, climate change: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM),	4
	TOTAL	**36L**

Recommended Books:

1. Energy Management- Murphy WR, G Mckay- Butterworth Heinmann, 2007
2. Energy Management, Audit & Conservation-De Barun, Vrinda Publications, Delhi, 2007
3. Eastop & Croft- Energy Efficiency, Longman, 1990
4. Turner- Energy Management Handbook, 2nd Ed., Fairmont Press, 1993

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	2	1		2	3	-	2	1	2	2	2	1
CO2	3	2	2	-		1	2	1	1	1	1	2	1	3	1
CO3	2	3	-	2	1		2	2	1	1	1	2	2	2	2
CO4	3	1	2	-		2		3	-	2	1	2	1	2	3

COURSE NAME: ARTIFICIAL INTELLIGENCE
COURSE CODE: ME802B
CONTACT HOURS: 36L
CREDIT: 3
Prerequisite: Probability, Matrix operations, Basic programming
Course Outcomes: Upon successful completion of this course, students will be able to achieve:
1. advanced Data Analysis skills
2. Create AI/ML solutions for various business problems.
3. Build and deploy production grade AI/ML applications.
4. Apply AI/ML methods, techniques and tools immediate.

Course Contents:

Module No.	**Syllabus**	**Contact Hrs.**
1.	Introduction to Data Science and AI & ML, Essentials (Tutorial) Programming, Statistical Analysis Initial Data Analysis	6
2.	Data Acquisition, Data Pre-processing and Preparation, Data Quality and Transformation, Handling Text Data, Principles of Big Data	6
3.	Data Visualization, Sampling and Estimation, Inferential Statistics, Linear Regression, Multiple Linear Regression, Non-Linear Regression	6
4.	AI: Application areas; AI Basics (Divide and Conquer, Greedy, Branch and Bound, Gradient Descent); NN basics (Perceptron and MLP, FFN, Back propagation) Convolution Neural Networks: Image classification; Text classification; Image classification and hyper-parameter tuning; Emerging NN architectures	6
5.	Recurrent Neural Networks: Building recurrent NN; Long Short-Term Memory; Time Series Forecasting;	6
6.	Deep Learning: Auto-encoders and unsupervised learning; Stacked auto-encoders and semi-supervised learning; Regularization - Dropout and Batch normalization	6
Total 36 L		

Text Books:
1) Artificial Intelligence A Modern Approach Stuart J. Russell and Peter Norvig.
2)ARTIFICIAL INTELLIGENCE, Third Edition, E. Rich, K. Knight, SB Nair, Tata Mc Graw hill

CO-PO Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	-	1	-	-	3	1	-	-	2	1	1	2	-	1
CO2	2	1	-	-	-	3	1	-	2	1	2	2	1	-	1
CO3	2	-	-	1	-	3	-	-	1	1	2	2	2	-	1
CO4	1	-	1	-	-	3	-	-	-	2	1	2	2	-	1

COURSE NAME: BLOCK CHAIN
COURSE CODE: ME802C
CONTACT: 3:0:0
CONTACT HOURS:36
CREDITS:3
Prerequisite: Basic mathematics.
Course Outcomes:
CO1: To understand the blockchain system by sending and reading transactions.
CO2: To explain the design principles of cryptocurrency.
CO3: To design, build, and deploy a distributed application.
CO4: To evaluate security, privacy, and efficiency of a given blockchain system.

Course Contents:

Module No.	Syllabus	Contact Hrs.
1	**Introduction:** Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.	**9**
2	**Distributed Consensus:** Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.	**6**
3	Cryptocurrency: History, Distributed Ledger, Bitcoin protocols- Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin.	**8**
4	Cryptocurrency Regulation: Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy.	**7**
5	Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.	**6**
Total Hours		**36 L**

Text Books:
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	-	-	-	1	1	-	-	2	-	-
CO2	2	1	1	2	1	-	-	1	-	1	2	1	1	-	1
CO3	2	2	2	1	1	1	-	-	-	-	1	1	2	-	-
CO4	2	1	2	2	1	1	-	1	-	-	2	3	1	-	1

COURSE NAME: NANOTECHNOLOGY
COURSE CODE: ME802D
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDIT: 3
Prerequisite: Material science

Course Outcomes: Upon successful completion of this course, students will be able to
CO 1: Identify 0D,1D,2D and 3D nanomaterials.
CO 2: Gain knowledge the optical and mechanical properties
CO 3: Interpret the magnetic and electrical properties.
CO 4: Illustrate the use of nanomaterials for different applications

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Introduction of nanomaterials and nanotechnologies, influence of nano over micro/macro, Comparison of nanotechnology with micro-manufacturing, Features of nanostructures, Background of nanostructures, Techniques of synthesis of nanomaterials, Tools of the nanoscience, Applications of nanomaterials and technologies.	7
2.	Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure, One dimensional, Two dimensional and Three dimensional nanostructured materials, Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties	7
3.	Mechanical properties of materials, theories relevant to mechanical properties, techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials.	7
4.	Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials, classification of magnetic phenomena.	8
5.	Nano thin films, nanocomposites, new application of nanoparticles in manufacturing of bearings, cutting tools, cutting fluids, medical science, soil science, membrane-based application, polymer based application.	7
	Total Hours	**36 L**

Text Books:
1. Mick Wilson, Kamali Kannargare, Geoff Smith, "Nano technology: Basic Science and Emerging technologies", Overseas Press, 2005.
2. Charles P. Poole, Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2008.
3. Mark A. Ratner, Daniel Ratner, "Nanotechnology: A gentle introduction to the next Big Idea", Prentice Hall P7R:1st Edition, 2002.

References:

4. T. Pradeep, “Nano the Essential Nanoscience and Nanotechnology”, Tata McGraw hill, 2007. 5. J. Dutta, H. Hoffmann, “Nanomaterials”, Topnano-21, 2003.
5. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004
6. I. Fujimasa, Micromachines, Oxford Science Publications, 1996.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	3	1	-	1	2	-	2	-	2	2	-	-
CO2	2	1	2	-	-	1	2	1	1	1	-	2	1	-	1
CO3	2	3	-	2	1	-	3	2	-	2	-	2	2	-	-
CO4	1	-	2	-	-	2	-	2	-	2	-	2	1	-	1

COURSE NAME: TOTAL QUALITY MANAGEMENT
COURSE CODE: ME803A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: The behavioural sciences, Supply Chain and Process analysis.

Course Outcomes:
CO1: Understand the concept of Quality
CO2: Operate the methodologies, methods, and tools of lean manufacturing system.
CO3: Identify requirements of quality improvement programs.
CO4: Organize for quality and development of quality culture through small group activities.
Course Contents:

Module No.	Syllabus	Contact Hrs.
1 Introduction	Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.	**8**
2 TQM Principles	TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.	**8**
3 Statistical Process Control	The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA-stages, types.	**8**
4 TQM Tools	TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.	**8**
5 Quality System	Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.	**4**
Total Hours (36 L)		

Text Books:

1. Paul James, Total Quality Management – An Introductory Text, Prentice Hall
2. Housen & Ghose, Quality Control and Applications.
3. O.P. Khanna, Industrial Engineering Management.
4. B. Dale, Total quality management, John Wiley & Sons, Ltd.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	3	3	3	3	1	2	-	-
CO2	3	3	3	3	3	2	1	1	1	1	3	2	1	-	1
CO3	3	3	3	1	1	2	1	3	3	3	3	1	2	-	-
CO4	3	3	3	2	3	3	3	2	2	3	3	1	1	-	1

COURSE NAME: SAFETY & OCCUPATIONAL HEALTH
COURSE CODE: ME803B
CONTACT HOURS: 36L
CREDIT: 3
Prerequisite: Strength of Material, Machine Design, Measurement and Instrumentation

Course Outcomes: Upon successful completion of this course, students will be able to achieve:
1. Primary knowledge of industrial and occupational safety and accident prevention
2. Understand occupational health and safety rules and regulations.
3. Analyze the safety management issues along with accident compensation acts.
4. Manage real life problems in the industries related to accident prevention and safety.

Course Contents:

Module No.	**Syllabus**	**Contact Hrs.**
1.	Development of industrial safety, Developments in Occupational Health, Occupational Safety and Health in India	3
2.	Accidents and their prevention Theory of accident, Anatomy of an accident, How Accidents are Caused , Cost of Accidents, Principles of Accident Prevention, Techniques of Accident Prevention, Safe Work Environment, Housekeeping, Job Safety Analysis, Investigation of Accidents, Ergonomics, Personal Protective Equipment, Promotion of Health and Safety, Basic Safety Programming	6
3.	Fire hazard Types of fire, Fire Hazards, Fire Explosion, fire prevention, Means of Escape in Case of Fire Inspection Safety Supervision Safety, Responsibility Safety Inspection, Fire prevention authorities, Rules Safety Training Safety Appraisal Safety Communication Safety Audit	5
4.	Occupational health and safety Occupational Health, Occupational Health Services in Places of Employment, Occupational Physician, Occupational Health in Developing Countries, Occupational Safety, Occupational Safety in Developing Countries, Promoting Occupational Health and Safety, Work Related Diseases, Occupational Health Hazards Recognition of Hazards, Industrial Hygiene, Occupational Diseases, basics of OHSAS 18001	6
5.	SAFETY, HEALTH AND ENVIRONMENT (SHE) EDUCATION AND TRAINING, SHE: elements of training cycle, Assessment of needs. Techniques of training, design and development of training program. Training methods and strategies types of training. Evaluation and review of training programs, Competence building technique (CBT), concept for training, safety as a on-line function. Role of multi-media communication, Applications of computers. Relevance of WTO regarding safety, health and Environment	8
6.	Health and safety management Basics of Safety management, Role of safety supervisor, planning for	4

	safety, Safety Policies, Safety Promotion, Safety Committee, safety education & training, Health and Safety Process, Measuring Safety, Risk Management and Loss Control	
7.	Accident compensation Brief introduction to different acts - The Dangerous Machines (Regulations) Act, 1983, The Employers' Liability Act, 1938 The (Indian), Fatal Accidents Act, 1855 The Public Liability Insurance Act, 1991, The Workmen's Compensation Act, 1923, The Employees' State Insurance Act, 1948, Role of National Safety Council, International labour office	4
Total Hours (36 L)		

Recommended Books:

1. Safety management Systems, A. Waring, (Chapman & Hall,1996)
2. Environmental Health & Safety Management – A Guide to Compliance, N.P. Cheremisinoff, M.L. Graffia, (Noyes Publin 2003)
3. Safety at Work, J. Ridley & J. Channing (5th. Edn.), (Butterworth & Heinemann, 2001)
4. Occupational Health & Hygiene, J.Stranks, (Pitman Publn., 1995)
5. Safety management: Strategy & Practice, R. Pybuss, (Butterworth & Heinemann, 1997)
6. Essentials of Safety management, H.L. Kalia, A. Singh, S. Ravishankar & S.V. Kamat, (Himalaya Publishing House, 2002)
7. Industrial Health & Safety Management, A.M. Sarma, (Himalaya Publishing House, 2002)

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	1	-	-	3	2	-	-	-	1	1	2	-	-
CO2	2	-	-	-	-	3	2	-	-	-	2	2	1	-	1
CO3	2	-	-	-	-	3	2	-	-	-	2	2	2	-	-
CO4	1	-	1	-	-	3	2	-	-	-	1	2	1	-	1

COURSE NAME: INDUSTRIAL POLLUTION AND CONTROL
COURSE CODE: ME803C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: ENGINEERING CHEMISTRY

Course Outcomes: On successful completion of the course, the learner will be able to
CO1. Gain an understanding of strategies, legal requirements and appropriate mitigation and treatment technologies for industrial pollution control.
CO2. Promote the solution of open-ended, multi-disciplinary problems typically found in industrial settings.
CO3. Explain principles of physical/chemical/biological treatment processes
CO4. Apply such knowledge to perform engineering calculations for simple systems

Course Contents:

Module No.	Syllabus	Contact Hrs.
1.	Types of emissions from Chemical industries and Effects of environment, Environment legislation, Type of pollution and their sources, Effluent guidelines and standards.	6
2.	Characterization of effluent streams, Oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, Controlling of BOD curve, Self-purification of running streams, Sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.	7
3.	Methods of Primary treatments: Screening, Sedimentation, Flotation, Neutralization, and methods of tertiary treatment. Brief studies of Carbon absorption, Ion exchange, Reverse osmosis, Ultra filtration, Chlorination, Ozonation, treatment and disposal.	6
4.	Introduction to waste water treatment, Biological treatment of wastewater, Bacterial and bacterial growth curve, Aerobic processes, Suspended growth processes, Activated aerated lagoons and stabilization ponds, Attached growth processes, Trickling filters, Rotary drum filters, and Anaerobic processes.	7
5.	Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: Collection of gaseous air pollutants, Collection of particulate air pollutants. Stack sampling: Sampling system, Particulate sampling, and gaseous sampling.	5

6.	Air pollution control methods and equipment: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipment particulate emission control: Collection efficiency, Control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP. Scrubbers and absorption equipment.	5

Text Book

1. Environmental Pollution and Control Engineering, Rao C. S., Wiley Eastern Limited, India, 1993.

Reference Books

5. Pollution Control in Process Industries, S.P. Mahajan, TMH., 1985.
6. Waste Water Treatment, M. Narayana Rao and A.K. Datta, 3rd Edition, Oxford and IHB, 2008.
7. Industrial Pollution Control and Engineering, Swamy AVN, Galgotia publications, 2005.

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	1	3	1	1	1	-	3	2	3	1
CO2	2	1	2	-	-	1	3	1	1	1	-	2	2	2	2
CO3	2	1	1	-	-	1	3	1	1	1	-	2	1	2	3
CO4	1	1	1	-	-	1	3	1	2	1	-	3	2	2	3

COURSE NAME: BIG DATA ANALYTICS
COURSE CODE: ME803D
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Data Structure, Design and Analysis of Algorithms, Database Management Systems, Statistics, Artificial Intelligence, Programming skills of Python.

Course Outcome(s): On successful completion of the course, the learner will be able to
CO1: Understand and explain the fundamental concepts of the Big Data Analytics which are primarily explored for making automated decisions using machine learning strategies on analyzing large scale structured as well as unstructured data distributed across multiple locations (Map Reduce, Hadoop and NoSQL Framework) underscoring the utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2: Identify and formulate an engineering problem of analyzing large scale data distributed across multiple locations to make automated meaningful decisions within the scope of Big Data Analytics Frameworks.
CO3: Explore relevant literature and apply the concepts of Big Data Analytics to solve problems of making automated decisions dealing with large scale structured as well as unstructured data using Map Reduce, Hadoop and advanced SQL Frameworks.
CO4: Excogitate ideas for proposing solutions to the challenging problems of Big Data Analytics.
CO5: Implement ideas of Big Data Analytics through developing feasible algorithms or frameworks and investigate their effectiveness in solving the relevant problems by analyzing the performances using proper techniques.

Course Content:

Module – 1: Introduction to Basic Analytics [10L]
Introduction: Big data overview, Analyst's perspective on data repositories, Current analytical architecture, Drivers of big data, Examples of big data analytics.
Life Cycle of Data Analytics: Phase 1: Discovery, Phase 2: Data preparation, Phase 3: Model planning, Phase 4: Model building, Phase 5: Communication of results, Phase 6: Making operational.
Basic Analytic Methods: Visualization, Dirty data, Data exploration versus presentation, Statistical methods for evaluation – hypothesis testing, difference of means, rank sum test, type I and type II errors, ANOVA.

Module - 2: Advanced Analytic Methods I [8L]
Clustering: Overview, K-means, Determining the number of clusters, Diagnostics.
Association Rules: Overview, Apriori algorithm, Evaluation of candidate rules, Application of association rules, Validation and testing, Diagnostics.
Regression: Linear regression - model description, Logistic regression – model description, Other regression models.
Classification: Decision trees – overview, General algorithm, Decision tree algorithms, Evaluating a decision tree, Naïve Bayes – Bayes theorem, Naïve Bayes classifier, Diagnostics of classifiers.

Module – 3: Advanced Analytic Methods II [8L]
Time Series Analysis: Overview, Box-Jenkins methodology, Autocorrelation function (ACF), Autoregressive model, Moving average model, ARMA and ARIMA model, Building and evaluating an ARIMA model.
Text Analysis: Steps in text analysis, Collecting raw text, Representing text, Term Frequency-Inverse

Document Frequency (TFIDF), Categorizing documents by types, Determining sentiments.
Map Reduce and Hadoop: Analytics for unstructured data – map reduce, Apache Hadoop, Hadoop Ecosystem – Pig, Hive, Hbase, Mahout.

Module – 4: Advanced Analytic Methods III [10L]
Technology and Tools: SQL essentials - Join, Set, Grouping extensions, Advanced SQL – Window functions, User-defined functions, Ordered aggregates, MADlib, NoSQL.
Integration of Techniques: Communicating and operationalizing an analytic project.
Creating final deliverables – Developing core materials, project goals, Main findings, Approach, Model description and model details, Recommendations, Providing technical specifications and code.
Data visualization basics - Key points, evolution of a graph, common representation methods, how to clean up a graphic.

Textbook:
1. EMC Education Services (Editor), Data Science and Big Data Analytics. John Wiley & Sons, 2015.
2. Mike Barlow, Real-Time Big Data Analytics: Emerging Architecture. O'Reilly, 2013.

Reference Books:
1. Nathan Marz and James Warren, Big Data: Principles and Best Practices for Scalable Real-time Data Systems. Manning Publications, 2015.
2. Venkat Ankam, Big Data Analytics. Packet Publishing Ltd., UK, 2016.

CO–PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	1	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	1	-	-	2
CO5	2	-	2	3	2	2	2	-	-	-	-	1	-	-	2